W. L. Ficker

A Typical Skull.

THE

INTERNAL ANATOMY OF THE FACE

BY

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THIS BOOK

IS

AFFECTIONATELY DEDICATED TO MY WIFE

MARTHA GATES CRYER

PREFACE TO THE SECOND EDITION.

Many years ago the author began to investigate the variations from the standard typical anatomy of the text-books which constantly presented themselves in his surgical practice. During the past twenty years hundreds of skulls have been sectionized and studied. This investigation completely overturned the author's conception of what was meant by the term typical. There is, doubtless, a typical or typal form for each bone, but it is not often found in nature. If we were to photograph a thousand temporal bones, for example, and make a composite of the entire number, the composite would properly be accepted as figuring the typal temporal. It is possible, though doubtful, that of the thousand bones, two or three could be found which would exactly correspond with the typal bone so pictured. This, in the writer's view, is strong testimony that the typal bone is ideal; that the actual is a variant. It is with these variants that the surgeon and dentist have practically to deal.

The author's investigations of the anatomy of the head have convinced him of the need for similar systematic study of the anatomical structure of the other parts of the body. For it can scarcely be doubted that the departures from the normal noted in the bony structures of the head and face will be found associated with equal variations of the other structures. It further shows that the text-book by itself is insufficient for the thorough study of anatomy; that the only authentic book of anatomy is the body itself; that, therefore, the use of text-books must be supplemented by the intimate study of the body.

In the preparation of this edition the text has been thoroughly and carefully revised to meet the requirements of those making special studies upon, or operating in, the region of which it treats. New

matter has been added to the extent of about 180 pages, including chapters on the teeth with their nerve and blood supply; on the distribution of the trigeminal nerve; on the uses of frozen sections; on the inter-relations between the nasal cavity and its accessory sinuses and cells. Wide and narrow dental arches have been further considered, and an extended chapter has been added in which impacted teeth, modern, ancient and prehistoric skulls and teeth have been compared and noted. With certain modifications the Basle nomenclature has been generally adopted.

The writer desires to acknowledge the encouragement and assistance received from Dr. Thomas C. Stellwagen, Dr. Edward C. Kirk, Dr. Arthur Hopewell-Smith, Dr. Herman Prinz, Dr. Rodrigues Ottolengin, Dr. Truman W. Brophy, Dr. Robert H. Ivy, Dr. A. H. Ketcham, Dr. James D. McCoy, and many others who have kindly furnished specimens or other material which have aided so materially in the preparation of this volume.

MATTHEW H. CRYER.

PHILADELPHIA, 1916.

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THE INTERNAL ANATOMY OF THE FACE.

CHAPTER I.

INTRODUCTORY.

Carefully conducted studies of numerous dissections prove conclusively that many of the stereotyped descriptions of the internal anatomy of the face are not justified by the facts; and that, therefore, the hard and fast rules for surgical procedures founded on these descriptions do not adequately cover the ground. In pursuance of these studies, hundreds of sections of the facial region have been cut and examined. The lesson they teach is that the accepted descriptions are to be received as only general truths, and that they cannot be depended upon or followed literally as a guide for the surgeon or dentist. The results of these investigations afford a basis for the explanation of the failure of many operations conducted on the lines of the accepted anatomical descriptions; such failures have been regarded as merely the natural percentage of unsuccessful treatment; whereas, they have probably been due to variations in the parts clearly within the limits of normality. This will be demonstrated in the following pages by many illustrations.

Anatomical Variations.—No man who spends any considerable portion of his time in the study of anatomy—that is, in actual dissections—can fail to note how great is the number of anatomical variations which he meets. So common are these that it cannot be said with exactness what are typical and what are atypical conditions. In other words, anatomy as a study is not to be classed among the exact sciences. It is not meant by this that there is not such a basis of anatomical science that general rules cannot be laid down, but the more closely the subject is studied the more variations as to details

are recorded. From the mandible of an animal, a femur, or even a tarsal bone, the nature of the associated bones, their sizes, positions, and forms can be satisfactorily deduced. Admitting this, however, there are still as many variations in the internal anatomy as there are differences in the external appearances. Especially is this true of the anatomy of the human head, as it is modified by climate, race, age, disease, occupation, and many other conditions.

Climate.—Climate and environment have a great influence in modifying the development of the bones of the head, as is demonstrated in the differing formations of the skulls of the great races of the world; and more markedly in branches of the same race living under diverse climatic and social conditions.

Age.—The changes produced by age are very marked. The skull consists of bones of both cartilaginous and membranous origin. In the fetus and infant these bones are soft and yielding; they receive deposits of certain salts of calcium, becoming harder and harder as age advances until the degeneration of senility sets in. In the jaws, constant changes are caused by the development, eruption, and loss of teeth and the consequent alterations of the alveolar process.

Disease.—Disease causes profound changes in the bony structures as well as in the other tissues of the body (see Fig. 45). In the presence of some disorders of the nutritive system—such for example, as rickets, either the bones may fail to become infiltrated with a sufficient quantity of lime salts, which would have the effect of leaving them soft and yielding; or, on the other hand, an undue proportion of calcareous material may be incorporated into the bones, with the opposite effect of making them hard and unyielding, thus modifying the physiological functions with which they are concerned.

Occupation, Diet, etc.—Occupation will modify the shape and character of the face and head, especially in youth. Those persons who are studious, and pass an indoor life, are likely to have a more delicate development of the face, with a larger brain-case than those who are brought up to a laborious outdoor life. The comminution of coarser foods will develop the muscles of mastication and their bony attachments. Numerous other facts might be cited to show the

influences of personal habit upon the course of anatomical development.

Asymmetry.—There are also variations in the same individual in the shape, size, and markings of the two sides of the face. In the bilateral bones such as the frontal, sphenoid, vomer, ethmoid, and mandible, one side is usually found to differ from the other. In the homonymous bones, as the maxillæ, the malar, the lachrymal, the turbinate, and the palate bones, the same variations are observed. This being the case, it will be readily understood that the internal openings and spaces, viz., the mouth, the nasal chambers, the orbits, the maxillary, frontal, and sphenoidal sinuses, the ethmoidal and other cells, will differ accordingly.

Diagnostic Importance.—It is clear that variations of the nature referred to must have a direct bearing on the diagnosis of morbid conditions for which there is no evident explanation, and even more so on the performance of operations for their relief. A knowledge of these variations will point the way to an understanding of many otherwise obscure and doubtful lesions. It will also show why, for example, following stereotyped ideas, the surgeon seeking to open into the antrum will occasionally enter the nasal cavity instead. It would seem that to the surgeon, and more especially to the dentist, such information is a necessity.

The main object of this volume is to present a digest of these revealed facts relating to the internal anatomy of the face—facts which have an important bearing on all surgical operations involving this region, and especially on the work of the dentist and the rhinologist. With this in view, the aim will be to call attention to misconceptions of the actual conditions; to correct errors which, having found currency, have been commonly accepted and more especially to enforce the idea that a slavish following of typical descriptions is likely to lead to disaster.

CHAPTER II.

GENERAL CONSIDERATIONS.

Anatomical Structures.—The anatomical bony structures of the facial region include the framework, superficially, of the external face and, more deeply, the walls of the various cavities and air spaces of the internal face. As with other bones, they consist of a cortical outer wall inclosing cancellated tissue, the latter being extremely fine and delicate in many cases, in some instances becoming so attenuated as to be almost lost. The exterior cortical parts are covered with a true periosteum, while the interior surfaces, those looking toward the internal cavities, as the mouth, nasal cavity, the frontal, maxillary, and sphenoidal sinuses, and the ethmoidal cells, are covered by a mucoperiosteum. From these characteristics, the former are known as non-mucous, and the latter as mucous or mucoid surfaces. It is important to consider the difference in these surfaces in the treatment of some of the diseases of the bones.

The dense exterior or non-mucous surface is roughened at various points by the actions of the attached muscles. The exterior cortical portion varies in thickness according to the amount of work to which it is subjected or the protection it has to afford. The greatest thickness is found in the mandible, the active bone of mastication, which occupies a position in the face where it is peculiarly exposed to the effects of external forces, such as blows, etc.

The inner or mucous surfaces, while dense and compact, are thinner, smoother, and more delicate. They are marked by depressions for the lodgment of the mucous glands, by grooves for the lodgment of the nerves and vessels, and also by elevations due to the attachment of the muscles.

Cancellated Structure.—The cancellated tissue found between the plates of cortical bone varies in thickness and compactness according

to the density, the position, and the functions of the bone. The arrangement of the trabeculæ is an interlacing network. To give bulk to the bone where required, and to diffuse shock, constitute the functions of the cancellated tissue. Through it pass the nerves and vessels to supply local structures and, by means of bony canals or tubes, the more distant parts. The bones of the head contain many canals and foramina for this last-named purpose, thus differing materially from the other bones of the body. This is a fact of surgical importance. For when these bones have become altered either by the breaking down of the tissue or by abnormal growths encroaching upon the foramina or canals, the functions of the nerves and vessels are interfered with, thus affecting not only adjacent tissues, but parts of the face and body remote from the seat of the lesion, causing abnormalities in the area of distribution, as atrophy, neuralgia, etc.

DEVELOPMENT OF THE FACE.

The bones of the brain case are in an advanced stage of development before the facial bones commence to be built. To such an extent is this so that the dermoid structures are nearly in contact with all of that portion of the head below and anterior to the notochord. At this time there is no opening into the alimentary canal.

The facial bones arise from the under surface of the brain case, from certain processes that push outward and downward, leaving a layer of dermoid tissue on their inner as well as their outer surfaces. This dermoid tissue becomes the mucous or epidermal lining of the mouth, the nasal cavities, and all internal surfaces of the face.

It is also from this dermoid tissue that the teeth and alveolar processes take their origin, and not from the developing buds or processes that form the remainder of the bones of the face; so that when the teeth are lost and there is no function for the alveolar process to perform, it is also lost. It is for this reason, also, that when the dermoid tissues are attacked by systemic diseases such as syphilis, scarlet fever, etc., the teeth and alveolar processes are involved simultaneously with the skin, as are also the bones of the face, which were covered

originally with dermoid tissue. It is quite possible that pyorrhea alveolaris may also be a manifestation of a dermoid disease.

When the dermoid appendages are entirely lacking at birth, and do not develop later on, the alveolar process will also be lacking.

The processes in front which pass down and forward are called the frontonasal; those on the side, the maxillary and mandibular; those situated deeply within the face are known as the spheno-ethmoid prolongations. The general tendency of these buds, forming the upper and lower jaws is to send processes toward the median line which form a union with their fellows of the opposite side. The bonds of these unions vary accordingly to circumstances depending upon their position, function and the age of the individual.

CHAPTER III.

THE MANDIBLE OR LOWER JAW.

The mandible develops from the first pair of the visceral or branchial folds called the mandibular plates, which in early embryonic life advance from the sides of the base of the cranium and meet at the median line, forming the symphysis menti.

The mandible is symmetrical in its general shape, although one side may and usually does differ from the other. It presents for study

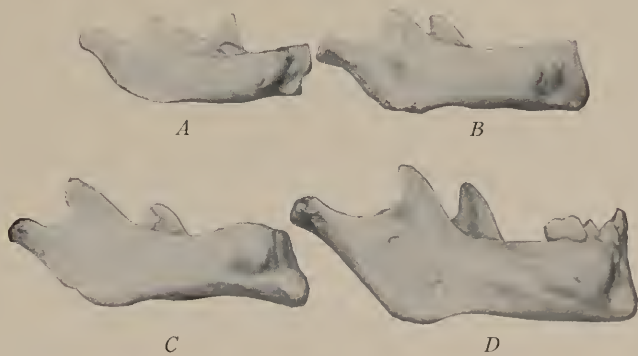


Fig. 1.—Four mandibles ranging from birth to eighteen months: *A*, at birth; *B*, at three months; *C*, at six months; *D*, at eighteen months.

a body which is horizontal in direction, with two rami extending upward to the articulation in the anterior portion of the mandibular fossa of the temporal bones. The angle (gonion) formed by the union of the lower border of the jaw and the posterior border of the ramus, varies considerably at different periods of life. Figs. 1, 2, 3 and 4 are views of the external cortical surfaces of the normal lower jaw at various ages, showing progressive changes in the angle between the rami and the body of the bone as life progresses. At birth (*A*, Fig. 1) the angle is very obtuse, but as the teeth develop and erupt, it becomes

less and less obtuse until about the time the last of the permanent teeth are erupted it is almost a right angle, as shown in Fig. 2.

Fig. 2.—Side view of a typical mandible at maturity.

As the muscles grow and increase in strength, that portion of bone to which they are attached also increases in size, giving the ramus a square appearance, especially in strong muscular persons (see Fig. 8).

After full maturity, as time passes, the muscular action becomes less and less, and the tuberosities, etc., throughout the body become

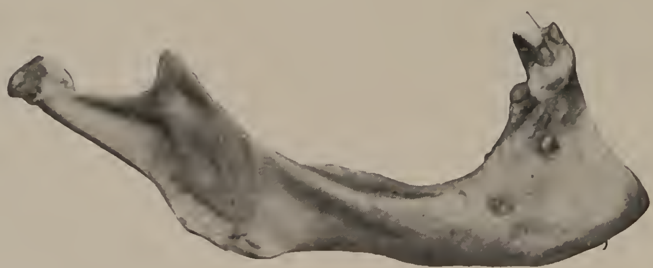


Fig. 3.—Mandible of aged person, showing a great change from that of adult life.

smaller. The same condition takes place at the angle of the jaw, and it becomes more obtuse as age advances. When the jaws can be kept apart with good teeth and normal, complete mastication, there is not so much change in the angles.

As the teeth become abraded, or when they are extracted, the alveolar process is resorbed, the horizontal planes of the jaws approach each other more closely, and the angle again becomes obtuse (see Fig. 3).

The teeth and their alveolar processes are placed on the upper portion of the body of the bone. The third molar is partially posterior to the anterior margin of the ramus, and a line can be drawn between the first and second premolars to the mental foramen.

Fig. 4.—Mandible of an aged person showing the mental foramina in the top of the body of the jaw.

The incisor teeth should have neither lingual nor labial inclination. Fig. 2 shows a fairly typical mandible: as is also shown in the skull marked Fig. 77.

The mental process gives prominence to the chin and lower part of the face. It belongs to man only, and is always associated with the genial tubercles. In the monkey there is a depression instead of the tubercles. The space between the halves of the body of the

mandible in the region of the premolar teeth is much wider in man than in the other mammalia, thus giving more freedom for the action of the tongue. The mental process, the genial tubercles, and the freedom of the tongue are severally and collectively concerned in the production of articulate speech. The writer also considered that the presence of a well-developed mental process contributes to a greater command of articulate speech than can be attained by individuals in whom it is small or underdeveloped; and as it extends outward beyond the line of the teeth, it—the mental process—gives the origin for the muscles that control the action of the lower lip, and when properly developed holds the latter in position to conform with the upper lip, thus perfecting the labial sounds.

In considering the manner in which deaf people can communicate orally by observing the action of the lips, and the fact that the deaf and blind can read what is being said, merely by gently placing the fingers upon the lips, one is inclined to the opinion that the lips are an important factor in the communication of thought as well as in the production of articulate speech.

The orbicularis oris muscle and its associates must have great freedom and power of action in order to produce the numberless varieties of motion necessary to this end. The facial nerve thus becomes one of the nerves of speech, as it not only controls the lips, but also the cheeks and some of the muscles of the soft palate.

In order that these oral muscles shall have a free and balanced action, the lower portion of the orbicularis and its associated inferior muscles must be carried forward to a line equal to that of the upper portion, thus as before mentioned, the mental process also becomes an important factor in articulate speech.

Mandibles of Different Races.—In comparing mandibles of different races and also of the same race great variations in general characteristic shape and size are found. The following figures illustrate a few of these variations:

Fig. 5 is a side view of an Indian mandible found in one of the buttes in western Kansas. It is a very powerful jaw, the angle is almost acute, 106 degrees, the distance from the condyloid process, which acts

as the fulcrum, to the coronoid process, the place of attachment of the temporal muscle, is 50 mm., which gives great power to the mandible.

FIG. 5.—A powerful mandible of an Indian found in buttes of western Kansas. (Loaned by Dr. Ketcham.)

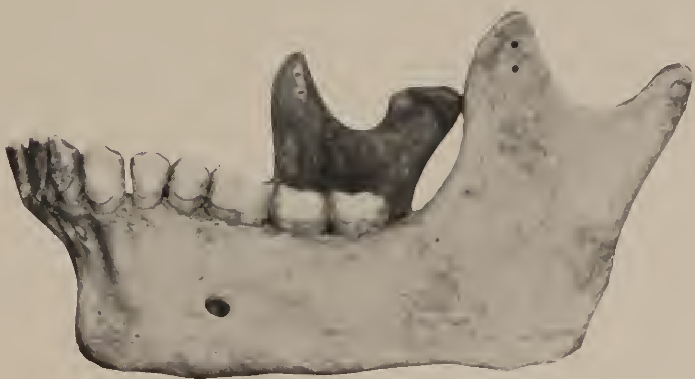


FIG. 6.—A mandible of a South African negro, a member of the Fan tribe.

Fig. 6 is from a mandible of a South African negro a member of the Fan tribe (see Fig. 78). The body is fairly typical, except that the angle is nearly a right angle. The characteristic features of this

mandible are caused by the position of the teeth and their alveolar processes, which are set forward on the body of the jaw. It will be

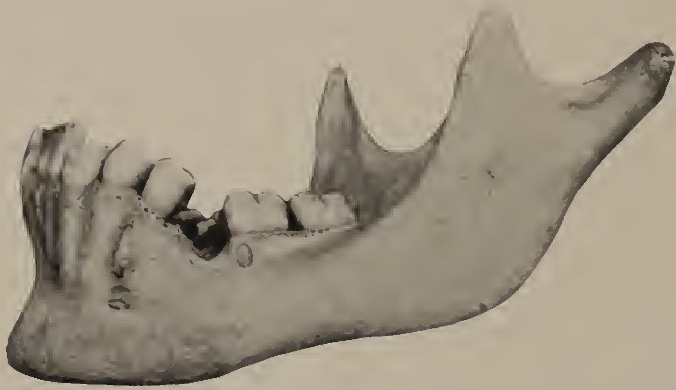


Fig. 7.—A mandible from a skull, showing prognathous jaws. (See Fig. 79.)

noticed that the third molar is in advance of the ramus about the width of a molar, and that a line drawn downward between the premolar teeth would pass across the body of the jaw a full width of a molar tooth in advance of the mental foramen. The canine and

Fig. 8.—A mandible of a heavy skull. (See Fig. 80.)

incisor teeth are placed in front of the jaw proper, with considerable labial inclination of the incisors. The mental process is not so promi-

nent as in Fig. 2, due in part to the carrying forward of the teeth and alveolar process.

Fig. 7 is made from a skull (see Fig. 79) showing prognathous jaws. In Fig. 6 the prognathism is evidently caused by the malposition of the teeth and their alveolar processes upon the body of the bone. In Fig. 7 the principal cause of prognathism is in the relation of the ramus to the body, which carries the body of the jaw so far forward that the mental process is much more prominent than in Fig. 6 and the anterior teeth have lingual inclination.

Fig. 8 is made from the mandible of a very heavy skull with massive teeth in excellent alignment (see Fig. 80) and when articulated

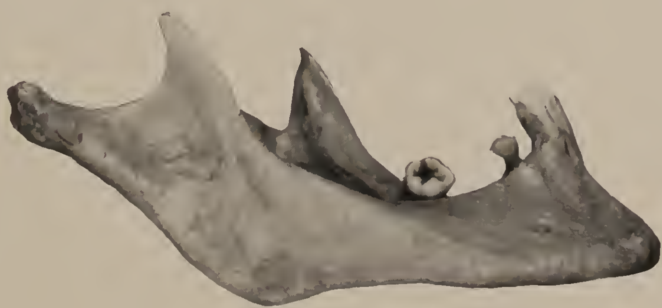


Fig. 9.—A mandible of a peculiar skull. (See Figs. 363, 364 and 365.)

with its skull there is fairly good occlusion. The marked feature of this mandible is the relation of the ramus to the body of the bone; its external angle is nearly a right angle, being 103° on the right side and 100° on the left.

Fig. 9 is made from a mandible of a peculiar skull (see Figs. 93, 363, 364 and 365). It is a great contrast to the mandible shown in Fig. 8. The angle of the ramus with the body of the bone is 139°. Age should be taken into consideration in this comparison, as the angle usually increases as age advances.

Fig. 10 is made from the mandible of a skull having a very flat face (see Fig. 82). There is a slight anterior occlusion. The angle of the jaw is obtuse—viz., 133 degrees.

Fig. 11 is made from the mandible of a Chinese skull (see Fig. 81). The rami are rather square and unite with the body of the bone at an

Fig. 10.—A mandible from a skull of a flat-faced person. (See Fig. 82.)

angle of 108°, which makes the mandible short. On the left side of the mandible there is an impacted lower third molar.

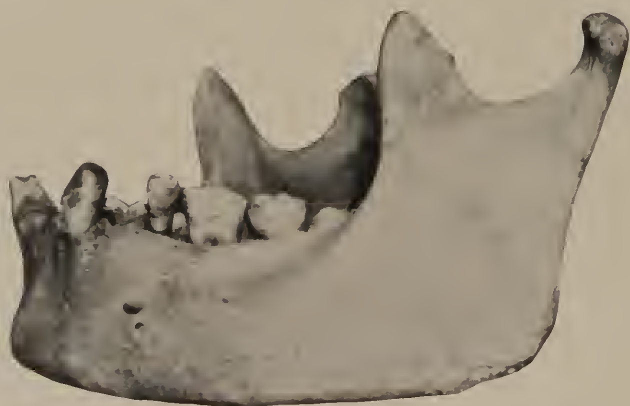


Fig. 11.—A mandible of a skull of a Chinese. (See Fig. 81.)

The following diagrams, each reduced one-half, give the measurements and angles of the mandibles in Figs. 2, 6, 7, 8, 9, 10 and 11:

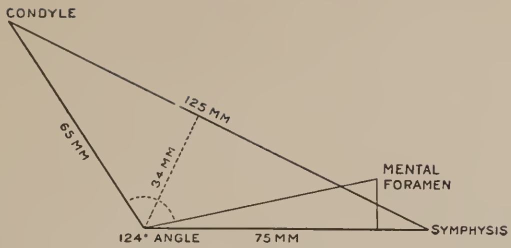


FIG. 12.—Mandible, Fig. 2.

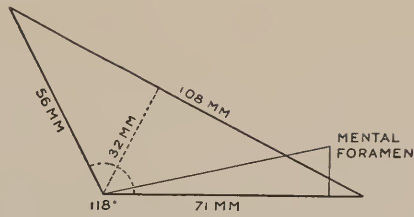


FIG. 13.—Mandible, Fig. 6.

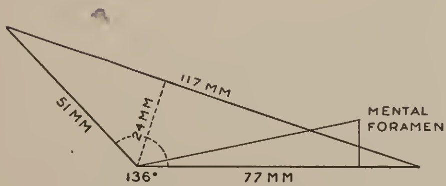


FIG. 14.—Mandible, Fig. 7.

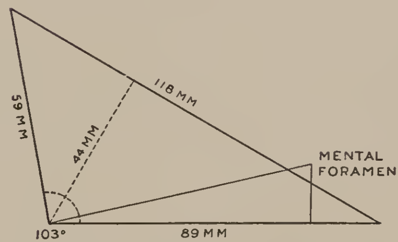


FIG. 15.—Mandible, Fig. 8.

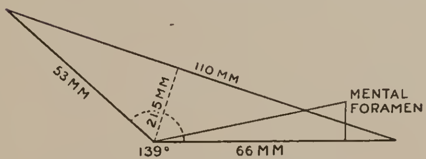


FIG. 16.—Mandible, Fig. 9.

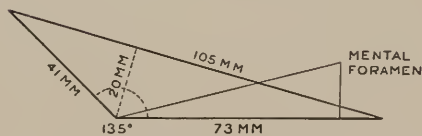


FIG. 17.—Mandible, Fig. 10.

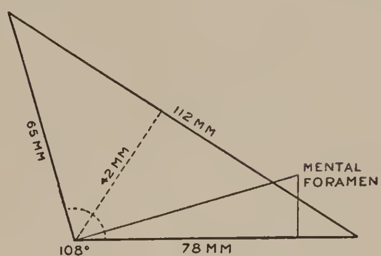


FIG. 18.—Mandible, Fig. 11.

The following diagrams illustrate the triangles of mandibles in skulls of various ages from eight months to old age:

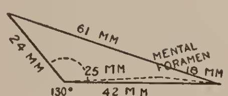


FIG. 19.—Age eight months.

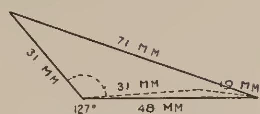


FIG. 20.—Age fifteen months.

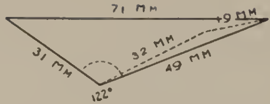


FIG. 21.—Age eighteen months.

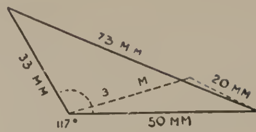


FIG. 22.—Age two years.

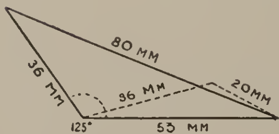


FIG. 23.—Age four years.

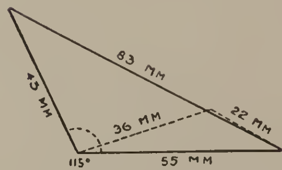


FIG. 24.—Age five years.

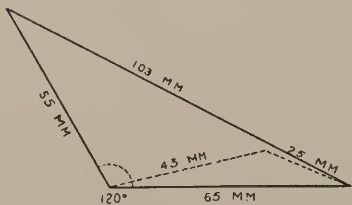


FIG. 25.—Age seven to eight years.

FIG. 26.—Age eight to nine years.

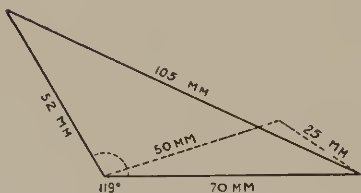


FIG. 27.—Age thirteen years.

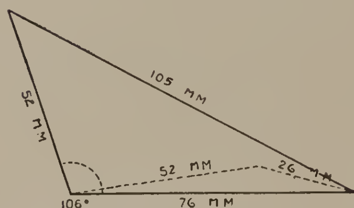


FIG. 28.—Age eighteen years.

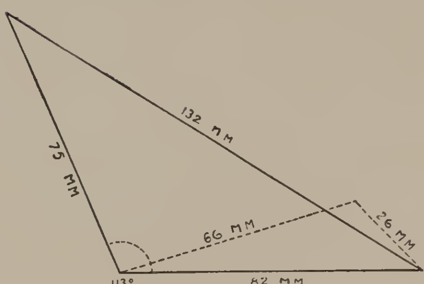


FIG. 29.—Adult.

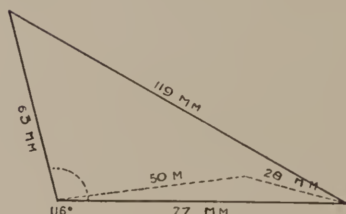


FIG. 30.—Old age.

FIGS. 19 to 30.—Diagrams of mandible, reduced one-half.

The Body of the Jaw.—The body of the jaw in transverse section, shows a U-shaped cortical or dense bony structure, the arms of the U terminating in the plates of the alveolar process—outer and inner—which are composed of a modified cortical bone with no definite line of demarkation between them and the body of the bone proper; the

FIG. 31.—Anterior lateral view of upper and lower jaws, with the external cortical portion of bone covering the roots of the teeth removed, exposing the cancellated tissue, the roots, and the cribriform tube. (Mandibular canal.)

function of the body, however, is quite different from that of the alveolar process.

The bone proper is covered with a true periosteum, the alveolar process with mucoperiosteum, the latter being thick and dense and containing many mucous glands. It is commonly known as gum

tissue. The space between the arms of the U is filled with fine trabeculæ forming the cancellated structure. The roots of the teeth are imbedded within this cancellated structure, each root being surrounded by thin, compact bony tissue, Lamina dura,[1] which approaches the cortical bone in density, but is cribriform (sieve-like) in character (see Figs. 31, 32 and 34).

Fig. 34 is an upper view of the mandible with the teeth removed, showing single sockets for the ten anterior teeth and double sockets for the six molars. The shapes of the sockets as shown correspond

Fig. 32.—Mandible with the cortical portion of bone removed from the body.

with the transverse section of the various teeth at the level of the margins. The septa between the sockets are cribriform in character.

Cribriform Tube.—Through the cancellated tissue passes the mandibular canal, which is, however, more accurately described by the term, "cribriform tube of the mandible." The function of this tube is to afford a protective passage for the mandibular nerve and the blood-vessels.

The cribriform tube passes downward and forward from the man-

[1] A. Hopewell-Smith, Dental Cosmos, August, 1913, p. 769.

dibular foramen, at first along the inner cortical portion, then, after it leaves the ramus, gradually crossing over through the cancellated tissue toward the outer cortical portion and downward toward the border of the U-shaped space. As it approaches the mental foramen, its course is near the outer cortical portion and along the lower border of the cancellated tissue, passing beneath the foramen to its termination near the roots of the incisor teeth. This tube can be removed from a normal jaw or isolated as shown in Fig. 33, taken from a specimen in which the cortical and cancellated tissues have been cut away,

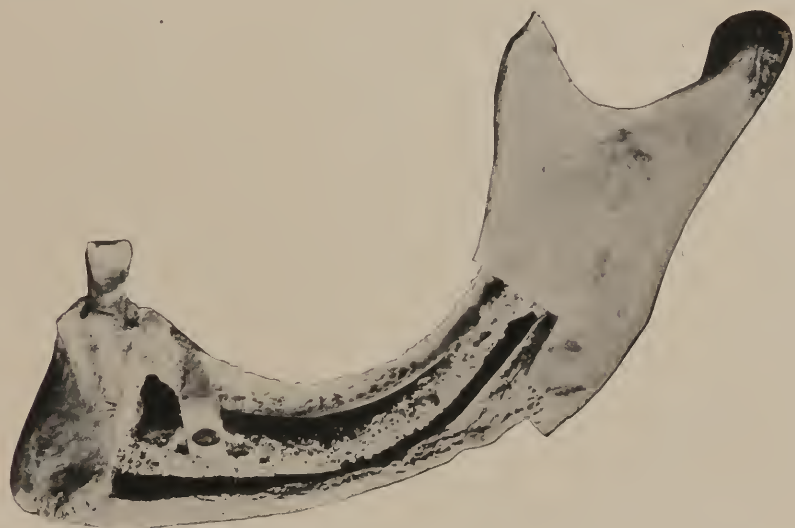


Fig. 33.—Cribriform tube (mandibular canal) of the lower jaw isolated.

exposing the cribriform tube. Figs. 31, 32 and 33 show that the cribriform tube is an independent structure, not merely a canal through the bone. In Fig. 31 it will be noticed that a portion of the outer wall of the tube has been removed, while in Fig. 32 the wall is left intact, showing its tubular form. The outer wall of the tube in the region of the second and third molars is extremely well shown in Fig. 31.

As the tube passes along the jaw its cribriform character becomes more and more marked until, beneath the first molar tooth, it becomes so opened, probably by a sort of stretching process coincident with

the growth of the bone, that the tube-like formation is almost lost, as is well shown in Fig. 31. Further forward it again resumes its original character. This main cribriform tube gives off lesser branch tubes which afford passage for the nerves and vessels to the substance of the bone; also, in more or less curved course to the roots of each tooth. The branch tube for the accommodation of the nerves and vessels

FIG. 34.—View from above of mandible from which all the teeth have been removed, showing the cribriform character of the septa of the sockets of the teeth.

to the mental foramen, is usually given off slightly anterior to the foramen, passing backward from the main tube to the foramen. This is almost invariably the rule—namely, that the tube to the mental foramen is in the form of a return or recurrent canal, mental canal, though occasionally it passes from the main tube as it approaches the foramen. The recurrent tube is well shown in Figs. 31 and 32. In the former, the anterior wall of the mental foramen has been cut

away, and in the latter, a narrow piece of paper has been passed through the foramen into the recurrent tube, showing its direction.

The Dental Branches.—The small lateral tubes which serve as nerve and vessel conduits to the roots of the teeth posterior to the mental foramen are given off from the main tube and pass upward and forward in a more or less curved direction, the degree of curvature varying according to the position of the teeth. Those going to the third molar are nearly vertical in direction. In those going to the second molar the forward direction is greater; in those to the first molar this forward direction is increased still more, while those to the second premolar have the longest curve of all. Sometimes the tube passing to the second premolar, instead of beginning at the main tube, is found as an offshoot of that going to the anterior root of the first molar. The small tubes going to the first premolar and the canine are branches of the recurrent tube of the mental foramen, and are curved slightly backward as they pass upward to the roots. In the unusual cases, where the branch from the mental foramen is not recurrent, but given off as the main tube approaches the foramen, the latter branches for these two teeth pass directly from the main tube, and with a slight forward curvature. The tubes for the supply of the incisors are also branches of the main tube, and curve slightly forward as they pass upward to the roots.

Method of Growth.—The cortical U-shaped portion of the bone is the framework of the jaw; its supporting structure. It grows by an interstitial process, each half having three fixed points between which the growth occurs—viz., the ramus, the mental foramen, and the symphysis menti. There is no doubt that the distance between these points increases, though the growth between the symphysis and the foramen does not occur at the same time as that between the foramen and the ramus. The periods of growth in these regions seem to correspond with the time of development and eruption of the teeth of the localities concerned. Thus, the increase between the mental foramen and the symphysis menti occurs during the time the incisor, canine, and premolar teeth are developing. After these teeth are erupted, there is little further increase in the length of this portion of the jaw.

From the mental foramen to the ramus the increase is inconsiderable until the time draws near for the eruption of the second and third molars, the greatest growth occurring during the development of these teeth, and generally ceasing after the eruption of the last named.

The contents of the U-shaped portion grow forward as the cortical structure increases in length, the teeth immediately posterior to the mental foramen—which are first developed in this region—being pushed forward successively by each developing and erupting tooth. It is this forward movement which gives the curvature to the various small tubes to the roots of the teeth, etc., and accounts for the stretching of the main tube until its distinctive character is nearly lost under the first molar. It also affords a rational explanation of the recurrent feature of the tube to the mental foramen; the end of this tube being attached to the wall of the foramen, when in the process of growth the mass of cancellated tissue is pushed forward, the tube itself is carried along with it, forming a loop.

The reason why the small tubes going to the first premolar and the canine curve backward is, that their points of origin have been carried forward with the return tube from which they spring. The small tubes going to the incisors curve slightly forward, as they arise from the continuation of the main tube near the point where it curves backward to the foramen.

Surgical Significance.—This anatomical arrangement has an important surgical significance in certain phases of the operation of resecting the mandibular nerve, for if the general teaching of anatomy be followed the surgeon is liable to be misled. If the operator cuts down to the mental foramen, then seizes the mental nerve and uses it as a guide while cutting the bone away with the surgical bur from the posterior wall of the foramen, he will find that the nerve cannot be followed as a rule, as the nerve and the canal do not pass backward. But if the anterior wall be cut away, the nerve can be followed down to the mandibular nerve, which may then be uncovered to any distance deemed necessary.

Pathological Significance.—The pathological significance of this bending backward of the nerve and its bony covering is that if any

injury be received in this region, or if any inflammatory condition be produced, either traumatically or by infection from diseased teeth, the nerve is liable to become impinged upon or compressed, thus causing pain or inflammation of the nerve itself. The writer has found neuromata more common in this region than at any other portion of the mandibular nerve, probably mainly due to the anatomical condition under consideration.

Records of Development.—Thus it will be seen that the anatomical structures, the relation of the various teeth considered with regard to the order of their development, and more especially the direction which the lateral branches of the main cribriform tube take to form

FIG. 35.—View of mandible (left side), with the cortical portion of bone removed together with the cancellated tissue, exposing the nerves and vessels within the cribriform tubes as they pass to the roots of the teeth.

their connection with the roots of the several teeth, supply us with permanent records of the methods of growth of the mandible during the period between childhood and adult life.

In the boiled and cleaned specimen, naturally all the contents of the tubes—the soft tissues—have disappeared; but the illustrations, Figs. 31 and 32, show clearly that the main tube and the smaller ones passing to the various teeth, and the finer tubes going to the inter-spaces and general cancellated tissue, have the same general direction and curvature as those going to the roots in their immediate vicinity.

Fig. 35 shows a specimen from which the soft tissues have not been removed. It shows the smaller tubes passing to the roots of the teeth,

with their contents, proving that these tubes do act as conduits for the nerves and bloodvessels.

Fig. 36 is from a specimen which was prepared by grinding away the labial and lingual surfaces of the bone and teeth until the pulp chambers and apical foramina were exposed on both sides of the teeth, leaving the tissues extending out of the foramina and through a portion of the bony cribriform tube below. In one tooth, at *A*, the lateral wall has been broken away, leaving the tissues uncovered by hard structures on the three sides. It will be seen that the nerve has been pushed slightly away from the wall. In this dissection and in many others it will be observed that the tissues passing into the teeth give

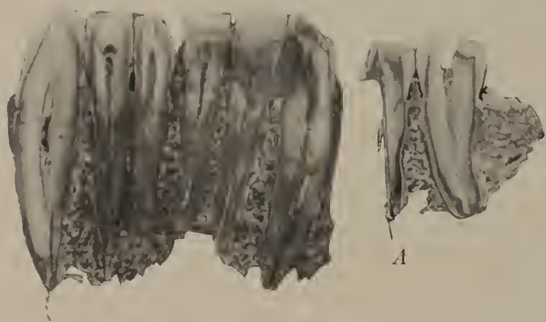


FIG. 36.—Ground section of the six anterior teeth and two left premolars.

off small branches from the nerves and vessels just below the apical foramen. So clear does this appear that the writer is of the opinion that the lower portion of the alveolodental periosteum is supplied from the same branches of the nerves and vessels which supply the pulp.

Pathological Significance.—The pathological significance of this condition is found in the reciprocal relation of pulp hyperemia and congestion with the same conditions affecting the apical portion of the peridental membrane so frequently observed in clinical practice.

Fig. 37 is a vertical transverse section through the jaws and tongue at the location of the first molars, affording a good idea of the cortical portion of the bone heretofore referred to, of its relation with the roots of the teeth, and of the position of the cribriform tube with the nerve

for which it serves as a conduit. (For further description of this illustration, see Fig. 196, page 220.)

Fig. 38 is a view of the anterior portion of the lower jaw shown in Fig. 37. The roots of the second premolar, it will be seen, are nearly

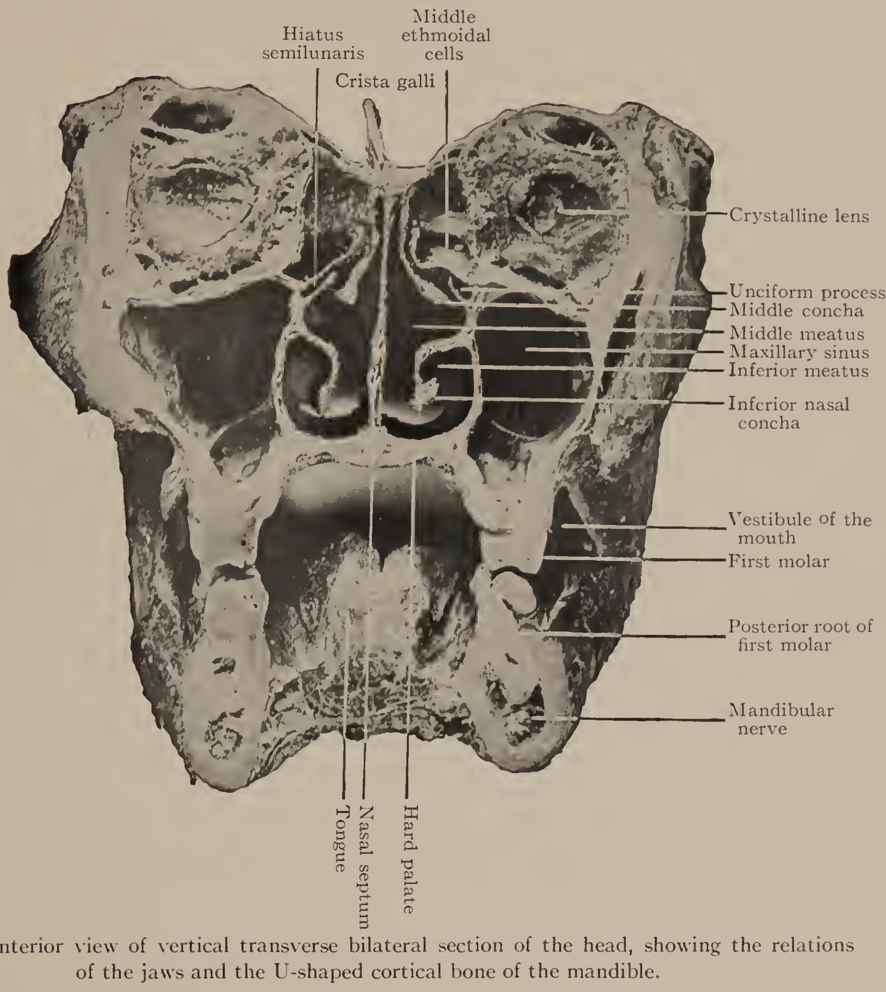


FIG. 37.—Anterior view of vertical transverse bilateral section of the head, showing the relations of the jaws and the U-shaped cortical bone of the mandible.

in a line transversely with the anterior roots of the first molar, a condition which is not at all uncommon. As the premolar roots are long and comparatively slender, extending below the roots of the molar,

often nearly to the mandibular nerve, while the bone at this point is usually very compact, the difficulty occasionally met with, in extracting these teeth without breaking them, is readily accounted for.

Surgical Pathology.—The relation of these roots to the cancellated tissue of the jaw has a pathological significance. If their pulps become diseased and infected, the infectious matter may pass out through the comparatively open tissue and burrow in various directions, setting up an osteomyelitis and affecting the other teeth, eventually causing an abscess, the discharge of which may pass either through the mental foramen or through the alveolar wall into the mouth, or even through the main portion of the U-shaped cortical bone into the neck. The

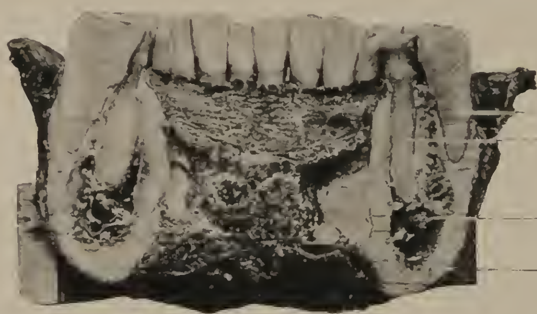


Fig. 38.—A posterior view of an anterior transverse section of the mandible made through the anterior root of the first molar, showing the U-shaped cortical bone.

necrotic process thus extended may include in its destructive area the apical regions of several adjacent teeth, causing devitalization of their pulps. It is the habit of some practitioners to inject hydrogen peroxide through the diseased teeth into abscesses of this character even before an external opening has been formed. The decomposition of the hydrogen peroxide in contact with the pus, generates gas with great force, if the gas has not a perfectly free outlet, it will burrow through the tissue in various directions of the least resistance and carry infection to any part of the mandible. The writer has seen cases in which the use of this drug, continued after extraction of the teeth has resulted in the loss of a large portion of the jaw (see Fig. 39).

Fig. 39 is from a photograph of three sequestra produced by injecting hydrogen peroxide into a diseased mandible, the bone in each of these cases regenerated.

Fig. 40 represents the left side of a lower jaw cut lengthwise nearly through its centre, exposing the cancellated tissue, the sockets of the teeth, and the cribriform tube or mandibular canal, with its branches to the alveoli. As the tissue is very frail, a considerable quantity of the trabeculæ was lost in the cutting. The outer section shows the direction of the recurrent tube for the accommodation of the mental nerve and vessels.

Figs. 41 and 42 represent two sides of a metal cast showing the cancellated structure within the U-shaped portion of the bone. It was made

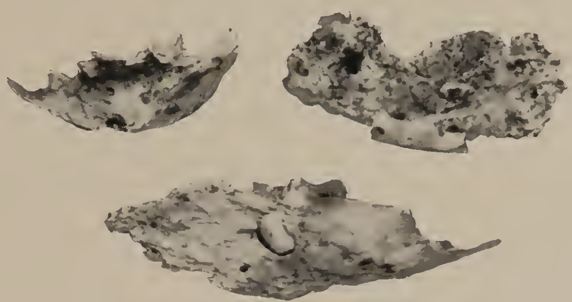


Fig. 39.—Sequestra from a mandible produced by the use of hydrogen peroxide.

in the following manner, from a perfect and thoroughly cleaned jaw with all the teeth extracted. After covering the openings of the sockets of the teeth with paper, the end of a slender tube about eighteen inches long was inserted in the mandibular foramen. The bone and tube were then invested in plaster of Paris mixed with a little asbestos. After the investment was thoroughly set and dried, it was heated to about 212° F., and a metal of low fusibility was poured into the tube. This metal passed into the cribriform tube and along its course, finding its way out through the many openings into the cancellated tissue and into the sockets of the removed teeth. After the plaster investment was removed, the body of the bone and the lower portion of the ramus were placed in a 10 per cent. solution of hydrochloric acid, which

dissolved the lime salts away, except where particles of the cancellated tissue are seen as white spots appearing through the metal. A transverse section of this preparation would show fine threads of bony tissue through the body of metal.

Fig. 41 shows the inner surface, in which the cast of the canal or tube may be seen also the space occupied by the red marrow of the

FIG. 40.—Longitudinal division of a mandible, exposing the cancellated tissues in the body of the jaw and between the sockets of the teeth.

bone, the nerves, bloodvessels, and their membranes. In Fig. 42, which pictures the outer surface, the dense spot near the border beneath the second premolar indicates where the nerves and vessels passed out of the mental foramen.

Fig. 43 is from a horizontal section of the upper and lower jaws, a little beyond the free margins of the alveolar processes. It shows the

Fig. 41

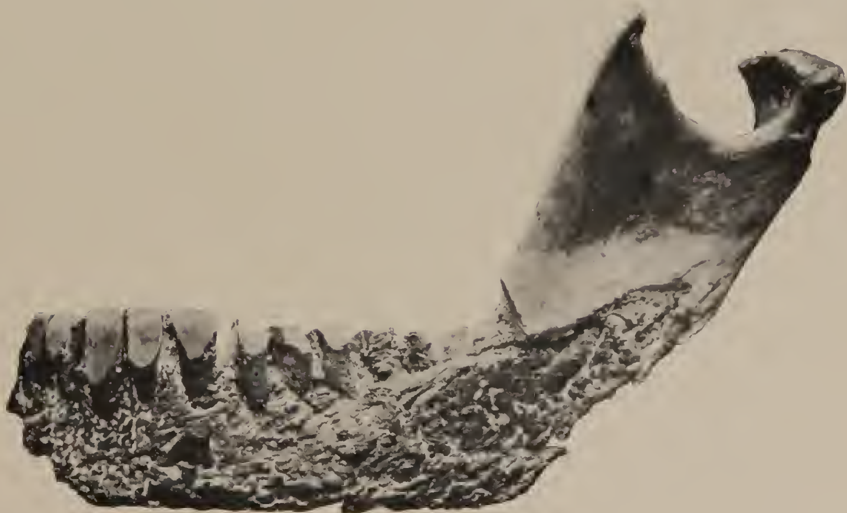


Fig. 42

Figs. 41 and 42.—Two views of the sides of a metal cast of the open spaces in the body of the mandible.

shape and position of the various roots on that plane, and their relation to the process and to one another. The conditions here shown are so common as to warrant their classification as the normal type.

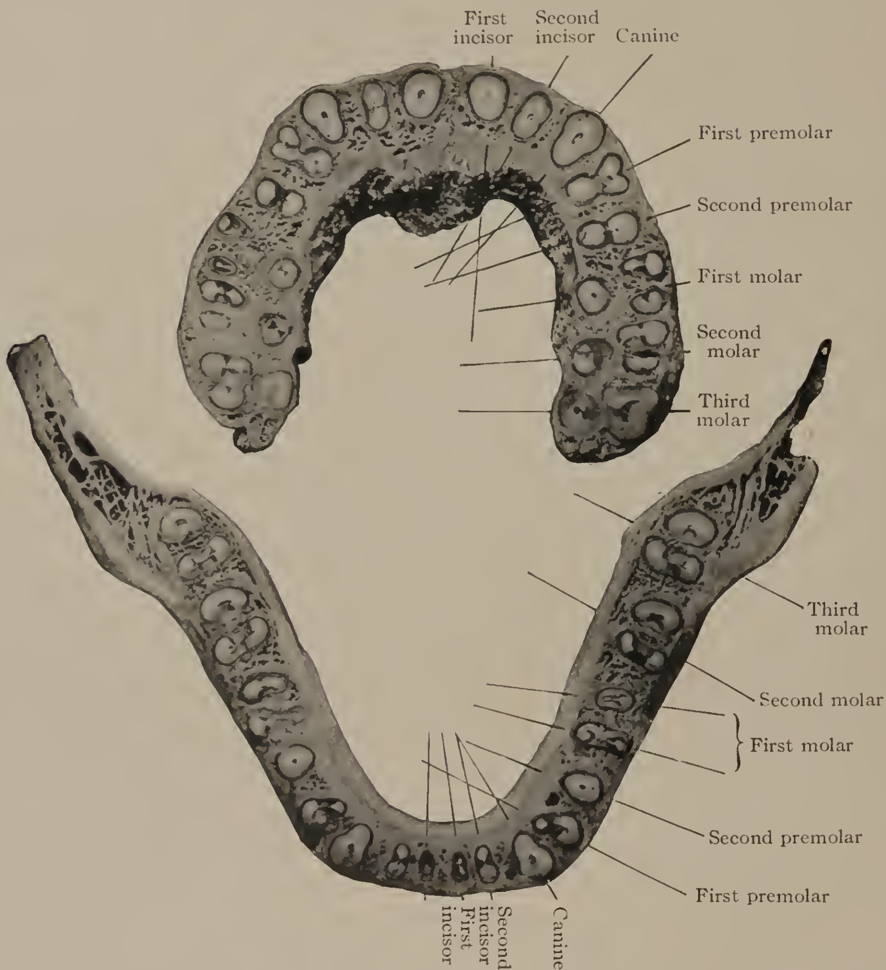


FIG. 43.—Horizontal sections of the maxilla and mandible cut a little beyond the free margin of the alveolar process, showing the forms and positions of the roots of the various teeth.

Particular attention is drawn to the slight distance between the roots and the plates of the alveolar process. It would be manifestly impossible in the operation of extraction, to force the beaks of forceps between

the roots and the alveolar process in such cases without breaking the latter on one or both sides. The not infrequent splitting off of a section of the alveolar process in extraction is thus readily accounted for. The lines in the cut represent the strongest axes in the teeth, those along which the greatest force is exerted in extracting operations, and which are usually at the same time the lines of least resistance of the surrounding tissues.

Fig. 44.—Horizontal section of the mandible cut in the region of the points of the roots of the teeth.

The roots of the teeth extend to various depths in the lower jaw, as is seen in Fig. 44, which represents a section cut horizontally, from the same subject as Fig. 43, though nearer to the ends of the roots. The ends of the roots of the second and third molars are plainly seen, also the tip of one of the roots of the first molar, and the roots of the first and second premolars. A little of the second incisors will be noticed, but the roots of the first incisors do not extend down so far. The cancellated portion, with the soft tissue filling the spaces, is well shown

in the posterior portion of this picture. The nerve is seen passing into its tube.

If all mandibles with their teeth were like those just described, surgery of the lower jaw would be comparatively simple. In fact, there would be little to do except in cases of traumatism; but unfortunately this is not the case, as will be demonstrated.

INFLAMMATORY CHANGES.

Inflammation within the lower jaw caused by diseased teeth, or by constitutional disturbances, may completely change the character of both the cancellated and cortical portions, by stimulating the bone-building cells of these tissues to undue activity. Under such circumstances, the cancellated tissue may be filled up or converted into a substance so nearly resembling the cortical bone that the line of demarcation is obliterated; while the cortical portion may be solidified—made more dense, ivory-like—and thickened, presenting conditions which very much complicate the situation and make the performance of operations difficult, and sometimes impracticable by the usual methods.

Fig. 45 is taken from a section made transversely through the lower jaw at the mental foramen of each side. On the left side the cortical U-shaped portion and the cancellated tissues are about normal and in condition similar to those in Figs. 31 and 32, while on the right side the cortical portion has thickened and become dense, and the cancellated tissue has become filled with a deposit of secondary bone. The only apparent reason for this difference is that all the teeth on the left side were in good condition, while on the right side the first molar had been much diseased, causing the inflammation of that side of the jaw; vascular changes induced activity of the functions of the osteoblasts, which caused the deposit of secondary bone.

Inflamed conditions in the jaws of children, occasioned either by abscessed teeth or by constitutional disturbances, will cause the deposit of secondary bone within the cancellated tissue, binding it to the U-shaped cortical portion. In such cases, when the time for the erup-

tion of the molars arrives, especially of the second and third, it is impossible for the cancellated tissue and the erupting teeth to glide forward as shown in Fig. 32. Many cases of impaction of the third molar are doubtless due to the existence of such conditions.

Surgical Pathology.—The normal and pathological anatomy of the two sides of the jaw shown in Fig. 45 would require different modes of surgical procedure. The teeth on the right side, being placed in an unyielding bone, would fracture in an attempted extraction, and the roots would remain in the jaw. The cutting of the bone down to the

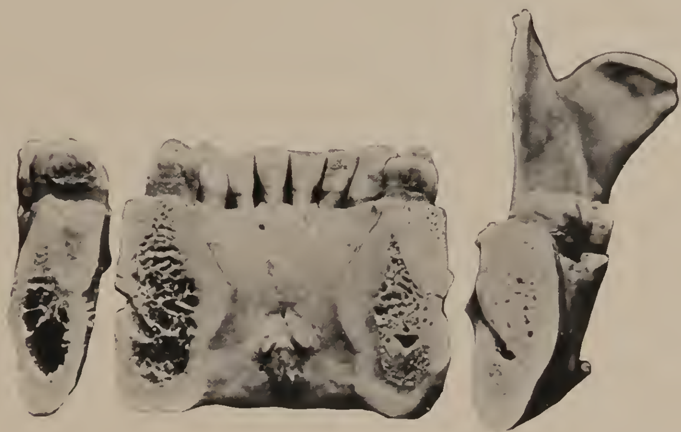


FIG. 45.—Transverse division of a mandible at the mental foramina. The left side is in an almost normal condition, while on the right side the cortical bone has thickened and become dense, and the cancellated tissue has become filled with secondary bone.

mandibular canal and nerve on the left side in a case of this character would also be quite a different operation from a similar operation on the right side. The first would be done with ease, the other with difficulty, and when the cutting was done it would be difficult to find and remove the nerve. Correction of irregularities of the teeth in the consolidated area would be almost impossible.

NECROSIS AND REGENERATION.

The formation of new bone to repair fractures throughout the human body is known to and observed by all surgeons, but the reproduction

of large portions of the mandible has not received the attention it deserves.

Before going into the details of this reproduction in the mandible it might be well to speak of the general growth of bone, about which there seems to be a difference of opinion.

Many of the text-books on general anatomy and even some of the modern works on surgery, teach that the growth of bone depends to a great extent on the presence of the periosteum. Keen's Surgery,[1] states, "In the long bones the vitality of the bone depends upon its relation to the periosteum and marrow. These two structures should be respected. In young persons the periosteum will regenerate new bone, and this property often may be used to the great advantage of the patient."

"The periosteum is the most active osteogenic agent, but the medulla is also very active—Osteophytes may develop during the healing of a fracture. They are most apt to spring from points of tendinous insertion or from misplaced pieces of the periosteal tissue."[2]

On the other hand, Dr. Clarence A. McWilliams, of New York, on "The Periosteum in Bone Transmission," says,[3] "The theory that contact with living bone is necessary for the subsequent life of grafts must be given up. Living bone-grafts have life inherent in themselves and are capable of permanent growth even when transplanted into the soft parts—48 per cent. of my bone grafts without periosteum were successful whether contact with living bone was made or not—periosteum transplanted into the soft parts will produce new bone in a certain proportion of cases."

Dr. Alexis Carrell and Montrose T. Burrows, of the Rockefeller Institute, New York, have reported in their article "Cultivation of Adult Tissues and Organs Outside of the Body."[4] "During the first hours of the cultivation of fragments of bone marrow and bone, the anatomic elements began to wander away from the tissue. After three or

[1] Keen's Surgery, vol. v, p. 732.
[2] Park's Surgery, third edition, p. 576.
[3] Journal of the American Medical Association, January 31, 1914, p. 351.
[4] Ibid., October 15, 1910, p. 1380.

four days, the little pieces of bone hidden in the marrow become visible, because almost all the cells had invaded the plasmatic medium. Around the tissue, there were radiating spindle cells and many red blood corpuscles. Leukocytes with active ameboid motion and large cells with granular cytoplasm and long pseudopodia had reached the remotest part of the medium. A few large spindle cells were seen crawling along the edges of the fragments of bone."

Sir William Macewen of Glasgow, has reported his experiments in his most valuable work[1] that the growth and repair of bone does not depend upon the periosteum. One of his concluding remarks is, "While not underestimating the periosteum as a limiting and protecting membrane of great use in physiological and pathological conditions, there is no data to indicate that it can of itself secrete or reproduce bone. It has no osteogenic function."

The process of normal growth of the mandible in length is quite different from that of the long bones, as there are no epiphyseal ends with the growth-producing intervening cartilage. As before stated, the growth of the mandible depends on an interstitial process which varies in different portions of the bone at different periods of life. This variation is to accommodate the development, growth and eruption of the teeth into their normal positions. If there be no living bone left on either side of that portion lost by pathological conditions or traumatism, there will be no regeneration of new bone, as this process for the repair of fractures and to furnish new bone is procured through the working of the osteogenic system in the bone remaining.

In looking up literature of regeneration of the mandible the writer finds very little as compared with that written upon the regeneration of other bones. The most modern works on surgery with a few exceptions scarcely mention it.

The following is taken from Park's *Surgery*, third edition, page 550, under the head of phosphorus necrosis: "In aggravated cases, such as are rarely if ever seen today since legislation has been brought to

[1] The Growth of Bone.

bear upon the subject, practically complete necrosis of the lower jaw, either *en masse* or in portions, was far from unknown, and the possibilities of regeneration of the bone was for a long time discredited, until the late James R. Wood of New York exhibited a specimen, both at home and abroad, which proved its possibility. Since then we have learned that it is possible for bone thus to regenerate, the cause of the disturbance having been removed."

One of the most interesting papers upon the subject of regeneration of the mandible was written by Dr. Percy, of Paris, in 1791, reporting five cases of regeneration of half or more of the lower jaw which had been destroyed by caries.[1]

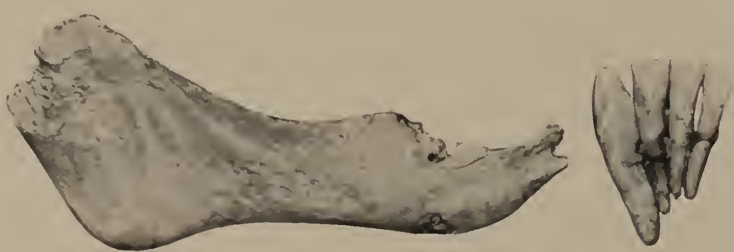


FIG. 46.—Sequestra from tubercular necrosis.

Cases of necrotic conditions of the mandible are of frequent occurrence; some are of slight extent only, caused by infected teeth, which by proper treatment recovered in a short time. There are many others, however, where the whole mandible is more or less involved, the gums and the soft tissues along the lower portion of the bone become very much swollen, the teeth loosen, and, though at first there may be no sign of pus, in a few days it will exude from around the necks of the teeth and may also begin to point in one or more places. Free incisions should be made both in the mouth and along the under surface of the bone, it sometimes being necessary to drill through the cortical portion of the bone to obtain as free drainage as possible. On passing a probe, denuded bone will be found, which condition may extend all along the outer and under surfaces of the bone from the symphysis menti to the

[1] Journal de Médecine de Chirurgie et de Pharmacie, Paris, 1791.

ramus and upward toward the mandibular notch. On opening the tissue so that the outer surface of the bone may be examined, the bone will be found to be somewhat darkened in color, there being numerous small soft spots indicating patches of caries, and in many cases the periosteum is absent having been lost by suppuration.

FIG. 47.—*X*-ray picture of hydrogen peroxide necrosis. (*X*-ray by Dr. Pancoast.)

Fig. 46 is made from a necrotic sequestra and four teeth, which had been removed from a tubercular patient. The bone around the roots of the teeth was so fragile that it crumbled in pieces, leaving only a little band of soft connective tissue holding the teeth together, the condyloid and coronoid processes were left in position. On removing the sequestra new bone could be felt at the bottom of the space which

eventually became entirely filled with osseous tissue. The patient was of course edentulous, but had a new half of a mandible well covered with gum tissue and in good union with the other half. There was no ankylosis.

FIG. 48.—*X*-ray picture of phosphorus necrosis, showing new bone formation on the lower border of mandible. (*X*-ray by Dr. Pancoast.)

Fig. 47 is taken from an *x*-ray picture, showing not only the spots on the surface but those in the internal structure of the bone. The body of the jaw appears to be in an advanced stage of necrosis, pus exuding through the tissue into the mouth at several points and through two external sinuses. The history of the case gave a diseased premolar tooth

which had been treated by hydrogen peroxide, then extracted, but the use of the drug was continued in the treatment of the socket and injected into the bone. Such cases are constantly occurring from the

Fig. 49.—*X*-ray showing necrotic condition of mandible. (*X*-ray by Dr. Pancoast.)

use of hydrogen peroxide upon diseased jaws. This treatment should be discontinued at once and the parts kept thoroughly cleansed by saline solutions.

Fig. 48 is made from an *x*-ray picture of the necrosed mandible of a man who worked in a match factory. It shows a diseased condition of the entire mandible due to phosphorus necrosis, but at the same time a rim of new bone forming along its base.

The following interesting case disclosed on examination complete pathological separation of the mandible on the left side in the region of the mental foramen. The bone and apparently the periosteum had been lost in the region of the second premolar, the bone around the first premolar was in a necrotic condition and the ends of the mandible on either side of the necrotic area were quite separated. Mastication was impossible and speech very much interfered with. The mandibular nerve had been divided, causing complete numbness of all that part supplied by it anterior to the lesion. This numbness continued for over a year after successful treatment and regeneration of the bone.

It would be interesting to know just how the reëstablishment of sensation occurs in such cases. It is a simple matter to understand the regeneration of a nerve where it does not pass through a long bony canal as in the mandible. When the body of the mandible or any portion of it involving the canal has been lost by necrosis it is a question whether regeneration of the bone is accompanied by reformation of the canal and nerve, there seems to be no affirmative evidence of this on record. In the opinion of the author, reëstablishment of sensation in parts normally supplied by the mental nerve is due to transference of this function to branches of the cervical plexis, and other branches of the fifth nerve, and not to regeneration of the mandibular nerve in the body of the bone.

Figs. 49, 50, 51 and 52 are made from *x*-ray pictures of a patient of Dr. R. Hamil D. Swing's. The patient, a boy, aged seven years, had a badly swollen face with pus discharging in the mouth and through a sinus in the neck. In October, 1912, an *x*-ray picture was made (see Fig. 49) which shows the necrotic condition of the body of the mandible, with two developing teeth. It also shows a portion of new bone forming apparently from the old bone. The new bone has a process extending backward in the direction of the condyle,

although a short portion of the old bone was completely denuded. It was thought best to avoid the removal of the dead bone so that it might act as a splint to the new bone.

Fig. 50.—*X*-ray showing regeneration of bone. (*X*-ray by Dr. Pancoast.)

Fig. 50 is an *x*-ray picture taken November 29, 1913, showing two thin pieces of lead wire passing around the remains of the original bone which is much reduced in thickness. The portion between the rings of wire is quite denuded, and can be plainly seen within the mouth.

Under the dead bone that is surrounded by the wires, the new bone may be seen to be forming, showing the new angle very plainly. The old angle can also be seen.

Fig. 51.—*X*-ray showing regeneration of bone of right half of mandible. (*X*-ray by Dr. Pancoast.)

Fig. 51 is from an *x*-ray picture taken June 6, 1914. It shows a further increase in the size of the new bone and a deterioration of the old bone.

X-ray pictures were taken from time to time to watch the process of regeneration. In February, 1915, the anterior end of the old bone near the canine tooth became loosened, the posterior end being still attached. On May 18, 1915, Dr. Swing removed the necrosed jaw (see Fig. 52). Had

this dead bone been removed as soon as diagnosed, the anterior portion of the mandible would have moved backward and to the side, but by keeping the old bone in place, in the nature of a splint, it gave time for a new half mandible to be regenerated. In all such cases the patient must be carefully watched as to general health, the mouth must be kept as clean as possible to avoid general septic troubles. Had there been any indication of disturbance it would have been necessary to remove the dead bone, fortunately the child remained healthy throughout the degeneration of the old bone, and practical experience has demonstrated that when a patient is in good healthy condition, with no constitutional disease, it is possible to await developments despite the necrosed condition of the jaw.

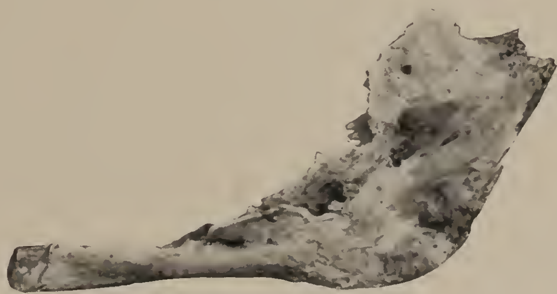


Fig. 52.—Sequestrum from diseased mandible.

Fig. 52 is a sequestrum taken from diseased mandible, as shown in Figs. 49, 50 and 51.

FRACTURES OF THE MANDIBLE.

Owing to the exposed position of the mandible, fractures may occur at the symphisis at the mental foramen, at the angle, at the neck of the condyloid process or any intermediate portion of the bone.

Fractures of the mandible are similar in character to those of the other bones, though compound fractures are most common; the displacement of the parts is caused by the action of the various muscles attached to the bone. The displacement is sometimes very marked, especially in a double fracture.

Fractures associated with the mouth are very apt to become a source of infection, not only to the surrounding tissue but to the general system.

In treatment, teeth and any fragments of bone found in connection with the break should be removed, and everything possible be done to avoid sepsis. Wiring of the teeth or the screwing of metal plates across the fracture should be avoided.

Cases of simple fracture with but little displacement, can be treated by the use of Barton bandage, reinforced when necessary by crinolin and plaster of Paris. If a bandage of this character becomes stretched, it should be cut in four places, the "slack" taken out and the places reunited by adhesive strips.

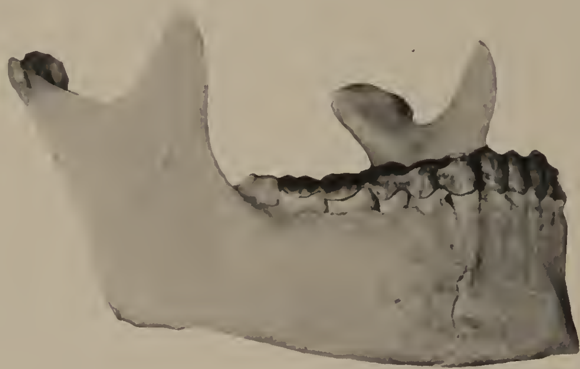


Fig. 53.—An interdental splint on a fractured mandible.

The best splints are of two characters: First, a swaged metal interdental splint as shown in Fig. 53; second, a swaged and soldered metal maxillomandibular splint as shown in *x*-ray picture (Fig. 54). When splints of this character are properly made and cemented into place the bandage can be discarded.

Fracture of the neck of the condyle is difficult to diagnose. The principal symptoms are pain in the condyloid region and malocclusion of the teeth, the molar teeth of the broken side striking together before the others. *X*-ray pictures should be made in both lateral and antero-posterior directions. The latter pictures should show the head of the

condyle carried inward and forward as seen in Figs. 55, 56, 57 and 58. In these fractures the continued actions of the temporalis, the masseter and pterygoideus internus pull the ramus upward and backward until the broken end of the ramus strikes the condyloid fossa, the

FIG. 54.—*X*-ray showing a maxillomandibular splint in position. (*X*-ray by Dr. Pancoast.)

muscular action of the pterygoideus externus carries the head of the condyle forward and inward, and it unites by ossification in this position.

The best operation, so far suggested for treatment soon after the accident, is to get all teeth in normal occlusion, if possible, and hold

them there by a maxillomandibular splint. By inaction, the muscles of mastication will relax, which will allow the head of the condyle to take a fairly normal position.

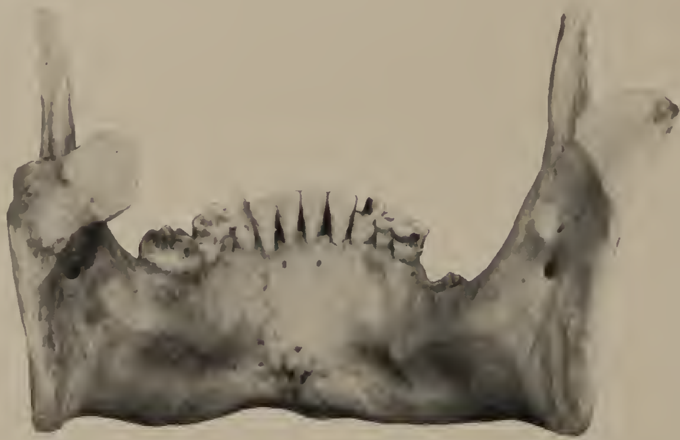


FIG. 55.—A mandible, showing the left condyle in an abnormal position.

If, as is the usual way, the head of the condyle is allowed to unite in the position shown in the illustrations, the best treatment is to have a dentist correct the occlusion as far as possible by mechanical means.

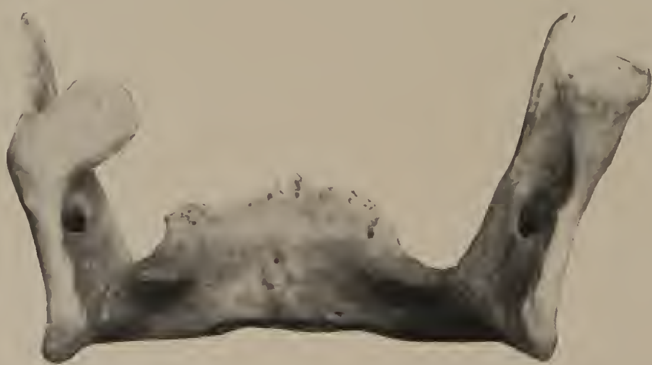


FIG. 56.—Showing a reunited fracture of the neck of the condyle in an abnormal position.

Fig. 55 is taken from a mandible showing the right condyle in normal position, while the left is fairly typical of a fractured neck of the condyle. The action of the pterygoideus externus carried the

FIG. 57.—Side view of a skull showing fractured neck of the condyle.

FIG. 58.—Anterior view of a skull, showing the position of the condyle process after the fracture of its neck.

head of the condyle forward and inward in which position the osseus union of the parts occured.

The relations between the head of the condyle and the mandibular foramen would more than likely interfere with the mandibular nerve and vessels. This illustration also shows that there had been another fracture extending from between the second incisor and canine teeth downward through the body of the bone.

Fig. 56 is from a similar specimen, showing similar condition of the head of the condyle.

Fig. 57 is a side view of a skull showing fracture of the neck of the condyle, the head of the condyle is bent inward and forward until it nearly forms a right angle with the ramus.

Fig. 58 is an anterior view of a skull, showing the mandible (Fig. 55) in position. The right side is normal, the left side shows the condyle carried forward and inward until it rests in the sphenomaxillary space. *X*-ray pictures of the living subjects will show similar conditions.

NEURALGIA.

Secondary bone deposit in the cortical and cancellated tissue of the face is an important factor in producing facial neuralgia, as branches of the trigeminal nerve pass through not only to the bone itself, but also to the region beyond in various directions. In the left side of Fig. 45 the spaces are comparatively open, while the right side of the same jaw is nearly solid; nerves passing through this half would be impinged upon, and neuralgia, the cause of which would be difficult to determine, would result. In neuralgia from this cause, the obvious treatment would be the burring away of the greater part of the abnormally solidified bone, using the surgical engine, a much better agent for its removal than the ordinary mallet and chisel.

SECONDARY DEPOSITS.

The cancellated portion of the mandible usually increases in compactness as persons advance in years. Along with the progressive increase in density of the tissues due to advancing years, other factors,

pathological in character, by which the teeth become diseased, set up an inflammatory condition which causes secondary deposits.

Fig. 59 shows several sections from a lower jaw, which was not quite normal, there being evidence of past inflammation having changed the structure of the bone. Several teeth had been extracted before death. In some of the sections only one canal is seen, while in others several appear, necessitating close observation to decide into which the main nerves and vessels have passed.

Fig. 59.—Sections made at different points from a mandible which was not quite normal in its density.

In the resection or removal of the entire nerve from the bone, a surgeon not anticipating this condition might easily clean out a portion of a canal without touching the main nerve. This mistake might not occur in the dry bone, but in the living, where the parts are vascular, the error could easily be made. In section *D* (Fig. 59) it will be seen that the anterior root of the second molar penetrates the true mandibular nerve canal. In case of abscess of this root, the discharge would

flow into the nerve canal, thence backward or forward along the nerve, causing great pain by compression.

Fig. 60 represents a specimen in which the roots of the third molar passed out through the inner wall of the lower jaw, at a considerable distance below the mylohyoid ridge. A putrescent pulp in this tooth would have discharged its infective matter at once into the submaxillary triangle. The writer believes that there are many serious unrecognized cases where devitalized teeth of this character cause infection of the

FIG. 60.—Part of a mandible, showing the roots of the third molar tooth passing through the inner wall into the submaxillary fossa.

tissues of the neck, and even of the thoracic cavity. Therefore, if diseased teeth in this region do not respond to treatment at once, they should be extracted, as not only ill health, but death itself may occur from their presence. The writer has seen large triangular swellings just under the jaw, which indicated that there was a focus of disease within the submaxillary triangle, a symptom of an enlarged submaxillary gland. Upon examination of the teeth a diseased molar was found, and after this tooth was removed the swelling subsided.

MANDIBULAR TRIANGLE.

A marked variation of the lower jaw is found in the relative distances between the centres of the two condyles and between these and the first incisors. These measurements have been commonly accepted as describing an equilateral triangle. The measurements of the jaws which have passed through the writer's hands do not bear out this hypothesis. In fact, the variations are as great as in any other feature of the face. In only one case was an exact equilateral triangle found. Some approached that figure, but in the great majority the sides of the triangle, taking the distance between the centres of the two condyles as the base, considerably exceeded the length of the base. In rare instances the base exceeded the length of the sides. The variations here noted would seem to indicate that while the equilateral triangle may be assumed as a general basic principle in the architecture of the lower jaw, the variations are the anatomical facts with which we are practically concerned so long as the hypothetical form remains unproved.

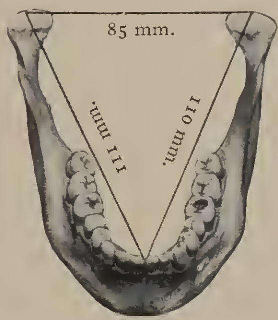


Fig. 61

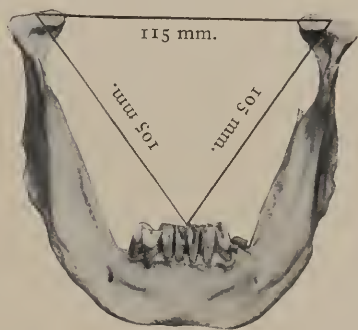


Fig. 62

Figs. 61 and 62.—Two mandibles showing variations in distance between the two condyles and from the condyles to the incisor teeth.

Figs. 61 and 62 are made from photographs of two jaws in which rather extreme conditions were found. In Fig. 61 the base of the triangle is nearly one-third shorter than either of the sides. In Fig. 62 the base exceeds either side. Between these extremes (and probably to

some extent beyond them on either side) every variation in the relation of the sides to the base of the triangle may be found in normal jaws.

In this description of the lower jaw or mandible, the intention has been to emphasize the necessity for the surgeon to promptly recognize departures from the accepted diagrammatic form of the normal jaw, and the results of pathological changes in its structures. The attempt has been to illustrate this necessity by typical cases which should serve to enforce principles, rather than enter into details.

THE MANDIBULAR ARTICULATION.

The mandibular articulation is formed by the condyloid process of the mandible and the anterior portion of the mandibular fossa of

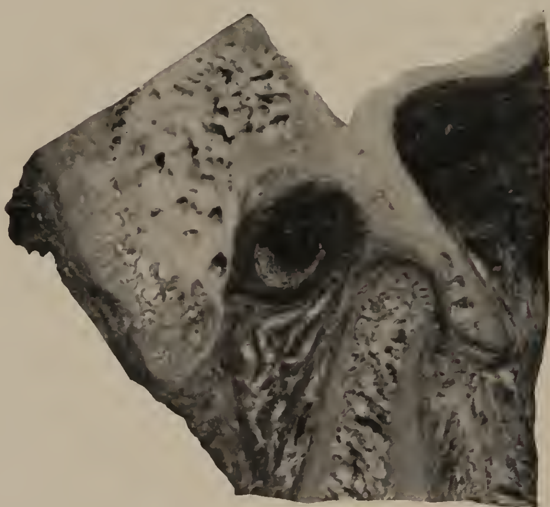


Fig. 63.—Lateral section showing the relation between the condyle and the acoustic meatus.

the temporal bone with the articulating disk between. The petrotympanic fissure is immediately behind the condyle with the articular tubercle in front.

This articulation brings the mandible into close relation with one of the most important bones of the cranium—the temporal. This bone forms a portion of the base of the brain case, it contains the

canal through which the carotid artery passes to supply the greater part of the brain and the eye, in the posterior portion is the great groove for the lateral sinus, the nerve of facial expression passes through a tortuous canal in the bone, and the organ of the special sense of hearing is located in the petrous portion, in close juxtaposition to the condyloid process of the mandible.

Fig. 64.—Vertical section showing meatus, acoustic tube, middle ear, etc.

Fig. 63 is made from a specimen, showing the relation between the condyloid process of the mandible and the mandibular fossa, the external acoustic meatus and the parotid gland.

Fig. 64 is a vertical section made through the left ear, giving a posterior view of the external acoustic meatus, the tympanic membrane and cavity, the auditory tube, and a section of the condyle. A most important point is the relation of the condyle to the temporal bone and

its surrounding tissue; the attachment of the pterygoideus externus is well shown. In case of fracture of the neck of the condyle, the muscular fibers would pull the head of the process inward and forward as described under the fracture of the neck of the condyle.

The movements permitted by the mandibular articulation are more varied and of a greater number than those of any joint in the body. The jaw has the power of extension and retraction, on one or both sides, it can be depressed and elevated, moved from side to side, and combines all the movements intermediate between these, thus allowing the gliding motion necessary to mastication. The articular disk (interarticular fibrocartilage) probably assists in these varied movements and acts as a multiplier of them.

If the mechanism of the articulation of the mandible be carefully examined it will be found that the sphenomandibular, temporomandibular, and stylomandibular ligaments act as suspensories to the jaw and have a tendency to fix the angle when it is carried slightly downward and forward, as when the mouth is partially opened. The muscular fibers of the pterygoideus internus and the external portion of the masseter muscles have the same tendency. The condyloid process of the mandible acts as the fulcrum or pivotal point of the bone. The point, or fulcrum, mainly through the action of the pterygoideus externus, moves forward with its cushion, the articular disk. While the jaw is being carried forward the mouth can be opened slightly, still retaining the fulcrum, or pivotal point at the end of the condyle, but as the mouth is opened wider, the fulcrum is gradually changed from the condyle toward the more central portion of the ramus and then toward the angle, probably eventually becoming the fulcral point through the partial fixation of the ligaments and muscles before referred to. By the action of the pterygoideus externus, the condyle is drawn forward, and the mouth is thrown wide open, with the condyle under or slightly in advance of the articular tubercle, as shown in radiograms taken when the mouth is wide open. It is thus that the pterygoideus externus becomes an opener of the mouth. The reason for the change of fulcrum, or pivotal point, may be found in the condition which is obtained in the pharyngeal region. If in opening the

mouth wide the head of the condyle acted within the mandibular fossa as the only pivotal point, the lower portion of the ramus with the body of the bone, the hyoid bone, the base of the tongue, and other associated tissues would be carried backward until the soft tissue coming against the postpharyngeal wall would interfere with the functions of that region. By the transfer of the point, this interference is avoided.

In man the mandibular articulation presents the combination of an arthrodial and a ginglymus or hinge joint. In the carnivora, this joint has no gliding movement as the condyle is a half cylinder working

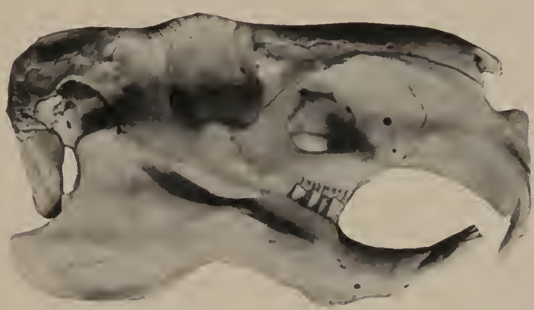


FIG. 65.—Side view of a skull of a Hydrocherus capybara.

FIG. 66.—Under view of a skull of a Hydrocherus capybara.

in a deep mandibular fossa of corresponding form, which only allows an up and down or hinge movement. In some of the herbivora the condyles of the mandible are only slightly convex and the mandibular fossa of the temporal bones are but slightly concave. This arrangement allows great latitude of motion, and the ginglymo-arthrodial nature of the joint is somewhat greater than it is in man.[1]

The mandibular articulation of the rodents is quite different.

[1] For full anatomical description of this joint see general text-book on anatomy.

Figs. 65, 66 and 67 are three views of the Hydrocherus capybara, the largest rodent now living.

Fig. 65 shows the grinding teeth in occlusion. It will be noticed that the lower incisors are considerably posterior to the upper.

Fig. 66. It will be noticed that the mandibular fossa (groove) is quite long anteroposteriorly, which allows great latitude in carrying the lower jaw forward and permits the upper and lower incisors to come into contact for gnawing purposes while the posterior teeth do not occlude.

The structure of these teeth consist of enamel plates somewhat like those of the elephant though the cement substance only binds the centres of the plates, leaving knife-like edges on the lingual and buccal surfaces, and partially on the occluding surface.

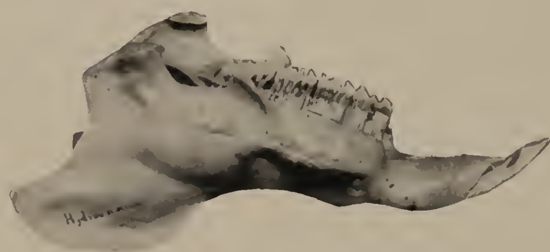


FIG. 67.—Side view of a mandible of a Hydrocherus capybara.

Fig. 67 gives a lateral view of the mandible of Fig. 65, showing that the condyloid process, the occluding surfaces of the grinding teeth and the incisors are nearly in a straight line and that the angle of the jaw extends backward beyond the vertical line of the condyles.

If the mandibular articulation of a vertebrate be shown to one familiar with the anatomy and occlusion of the teeth in relation to this joint, he could readily classify the animal and give the character of the mandibular articulation also of the maxillary sinus and the alimentary canal.

At birth the mandibular articulation of the vertebrates is very similar; but as life advances the similarity disappears, conditions change in proportion to the environment and character of the food. In man the mandibular fossa is quite flat at birth, and there is but

little change until the child begins to masticate, it then deepens rapidly until about puberty. As age advances the articulation again changes and the mandibular fossa becomes more flattened like that of childhood.

Fig. 68 is made from a side view of a human skull at the time of birth. The mandible articulates in its fossa, the condyloid process is in close juxtaposition to the acoustic process. The fossa is flat and shallow, the condyles are short and rounded. Posterior to the fossa,

FIG. 68.—Side view of skull at birth.

is the acoustic ring upon which the tympanic membrane is suspended, and also upon which the greater portion of the wall of the external acoustic meatus is built, there is but little change until sometime after birth, it will be noticed how slight is the protection over the organ of hearing and the articulation. An inflammatory condition of this region from any cause, could produce various kinds of malocclusion of the teeth and serious acoustic troubles.

Fig. 69 is made from the under surface of a human skull at birth. It will be observed that the lower jaw occludes within the upper.

The condyloid process is close to the wall of the external acoustic meatus. Part of the tympanic membrane and the auditory ossicles have been preserved, but there is no bony protection to these delicate structures at this period, consequently they are often injured at the time of birth by the use of forceps.

Fig. 70 is made from a side view of a skull, showing a slight forward occlusion of the mandibular teeth. It will be noticed that the mandibular articulation is quite like that of the carnivora, the fossa being

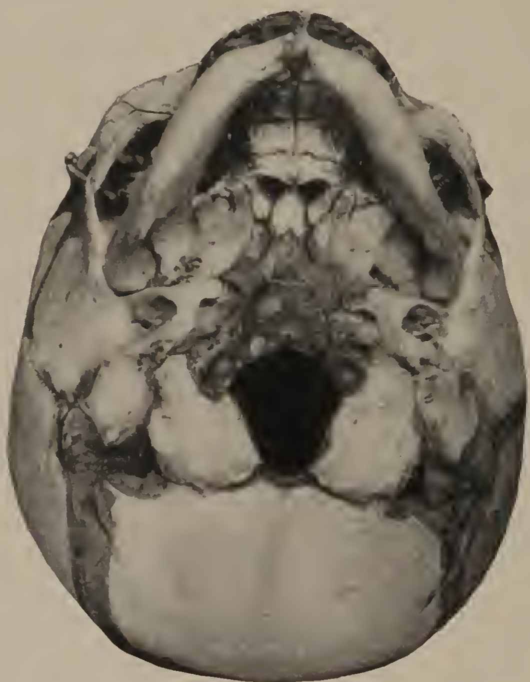


Fig. 69.—View of base of skull at birth.

deep and narrow, allowing but little play in the joint. The anterior wall of the external acoustic meatus is defective, its resorption may have been caused by the pressure of the condyle, or the wall may never have been formed.

There are many cases where the anterior osseous wall of the acoustic meatus is lacking and where the condyle presses against the mem-

branous meatus, thus interfering with hearing. Otologists treating such cases often request the patient to open the mouth wide, this usually draws the condyle forward, giving a clear view to the tympanic membrane.

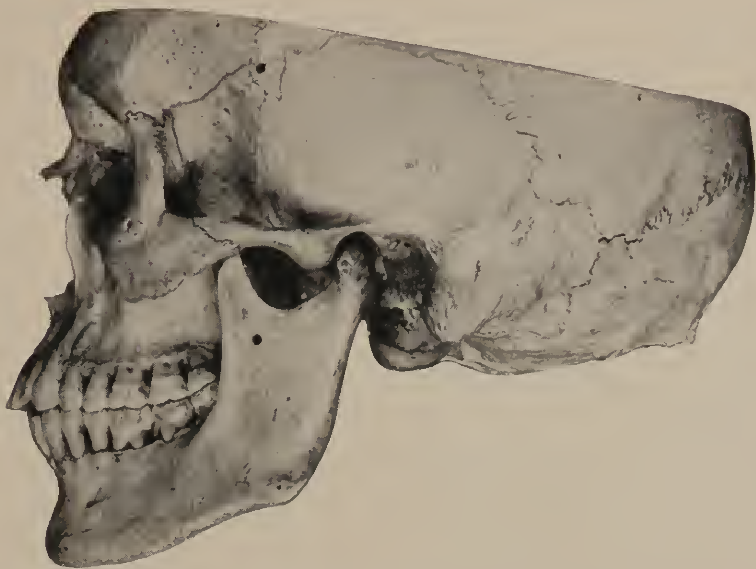


Fig. 70.—Side view of skull, showing forward occlusion of mandibular teeth.

From the relation shown in the structure of the mandibular articulation, it is very evident that in changing the position of this articulation, a forward placement of the jaw could be accomplished with less risk than a backward placement.

These pathological points should be taken into consideration when applying pressure on the lower jaw for correction of malocclusion.

CHAPTER IV.

THE MAXILLÆ.

The upper jaw, from a surgical point of view, includes the right and left maxillæ, part of the ethmoid and sphenoid bones of the cranium, and in addition all the other facial bones except the mandible. The surgical operation of removing the right or left maxilla does not usually involve the removal of the entire bone, for the frontal process, the floor of the orbit, and the zygomatic surface may be left. In its removal, however, the inferior concha, portions of the lacrimal, the palatal, the zygoma, and the ethmoid bones will probably be removed with it. Especially is this true in the general method of operating, but if the resections are made with the assistance of the surgical engine, the greater portion of the associated bones may be left undisturbed.

Architectural Features.—The maxillæ are situated beneath the walls of the anterior fossæ of the brain-case and rather loosely attached by what may be termed buttresses and flying buttresses. In the centre, near the nasion, the frontal processes rest firmly against a buttress in the median line, the maxillary processes of the frontal bone. Below is a flying buttress, the nasal septum, especially that portion formed by the vomer, which passes upward and backward from the interarticulating ridge of the maxillæ and palate bones to the buttress-like body of the sphenoid bone, where it is firmly held or braced in place by the vaginal processes. Laterally the upper jaw is supported through the zygomatic bones by the zygomatic processes of the frontal bone and the flying buttresses of the zygomatic arches to the temporal bones at the sides of the skull; posteriorly by the pterygoid process of the sphenoid, with a portion of the palate bone interposed.

The buttresses, situated and distributed as they are, not only afford support against forces acting externally, but also dissipate and diffuse shocks which would otherwise be transmitted to the cranium. As a consequence of its construction, but little force in a forward direction

is necessary to detach the upper jaw from the cranium, though it will withstand a blow of great force received from below through the lower jaw or from in front, or even from the side.

Pathological Relations.—The upper jaw gives support to one-half of the teeth and like the mandible is subject to defects of development and to various pathological changes, chief among which may be mentioned cleft palate congenital or acquired, necrosis, caries, sarcoma, odontoma, odontocele, impacted and supernumerary teeth. It may also be affected by alveolar and dento-alveolar abscesses, diseases of the mucous-lined sinuses and air spaces, which last may also give rise to such symptoms as impaired respiration and the discharge of offensive matter. Tumors or abscesses of the maxillary sinus often grow to such a size as to elevate the floor of the orbit, depress the roof of the mouth, and force outward the walls of the cavity, distorting the contour of the face in the region of the canine fossæ. Neuralgia in the teeth may be symptomatic of disease of the bones of the jaw, and neuralgia in many regions of the head is traceable to the teeth.

The under surface of the upper jaw is bounded by the alveolar process and the roof of the mouth or the palatal processes, both of which are covered by periosteum and mucous membrane (mucoperiosteum). That portion of the mucous membrane over the alveolar process is thick and dense, and is known as gum tissue; it contains but few mucous glands, while the portion covering the roof of the mouth is not so dense, and is well supplied with racemose mucous glands.

The Alveolar Process.—The alveolar process is made up of two plates, an external and an internal, consisting of dense, compact, cortical bone. The outer plate extends upward and merges, without a line of demarkation, into the outer surface of the true maxilla. The inner plate extends upward and inward and is continuous with the palatal process of the palate bone and maxilla proper. The space between the plates is occupied by the sockets of the teeth, the alveoli, which are surrounded by a very thin cribriform plate of bone (the lamina dura[1]) by cancellated tissue, nerves, vessels, etc. The alveolar

[1] A. Hopewell-Smith, Dental Cosmos, August, 1913.

process belongs to the teeth and is developed with them for the purpose of holding them in position. It disappears in various degrees after the teeth are lost, sometimes before, more especially when there is pyorrhea alveolaris, and also as an indication of advancing age. Should the alveolar process be the primary seat of disease, sound teeth will loosen and may fall out. The outer alveolar plate is resorbed after the loss of the teeth to a greater extent than the inner one, which is of advantage to the dentist in fitting artificial teeth to the gums; consequently, in extracting teeth this fact should be remembered, so that injury to the internal plate may be avoided. At the same time, no particular harm results from the removal of a small portion of the outer plate, though the loss of any gum tissue should be avoided if possible.

In the alveolar process, each tooth has its own individual process; as the tooth develops and pushes into its position the process grows around it. These processes are bound together by connective tissue, which vary in number and strength of union in different parts of the circumference, becoming less strong in the upper jaw in the processes between the canine and second incisor teeth, while between the two first incisors there are no bonds of union; consequently when a force is applied for the purpose of spreading the dental arch, the circumference increases by the stretching of the connective-tissue fibers of the alveolar processes, and as the interpremaxillary suture is the weakest point, it naturally opens when sufficient force is used.

The interpremaxillary suture must not, however, be confused with the intermaxillary which does not open (see Fig. 74).

Sutures of the Roof of the Mouth are seven in number (see Figs. 71, 72, 73 and 74).

The median palatal suture begins at the centre of the free margin of the hard palate or posterior nasal spine, passes forward between the palatal bone, then between the true maxillæ to the incisive foramen, then forward between the premaxillæ, terminating at the anterior nasal spine. It is divided into three sections, namely, the interpalatal, the intermaxillary, and the interpremaxillary sutures. There are four transverse sutures, two situated between the palatal bone and the

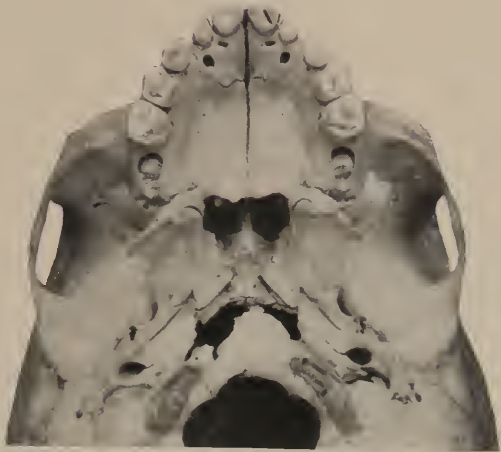


FIG. 71.—View of under surface of a skull of about five and a half years of age, showing the roof of the mouth with the deciduous teeth in position and the various sutures.

FIG. 72.—Anterior view of the same skull as Fig. 71, showing non-union of the two premaxillæ in the median line.

palatal processes of the maxillæ and two pass outward from the incisive foramen between the maxillæ and premaxillary bones, they also pass between the canine teeth and the second incisors. When there is a lack of union in the first two portions of the median palatine sutures and one passing between the canine tooth and the second incisor, there is a single complete congenital cleft palate. If the two sutures passing

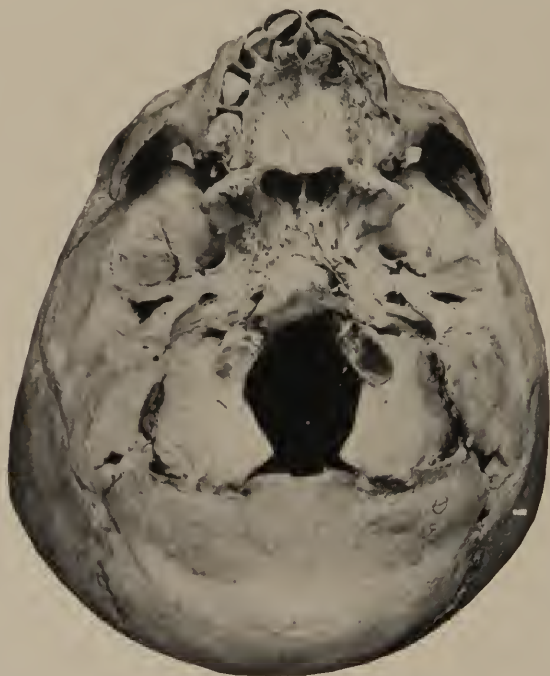


FIG. 73.—Under view of a child's skull with sutures radiating from the media suture toward the interspace between the teeth.

between the canine teeth and the second incisors are not united, there is a double complete congenital cleft palate.

Fig. 73 is from a child's skull, showing more than the usual seven sutures, radiating from the median suture out toward the interspaces between the teeth. Prof. Paul Olbrecht[1] has also recognized similar conditions.

[1] Transactions of the American Society of Orthodontists for 1908.

Fig. 74 gives a fair idea of the alveoli of the upper jaw, and indicates the position of the seven sutures of the roof of the mouth. It will be observed that there are two sockets for the roots of the second premolar teeth. This is not usual, though it occurs occasionally. On the right side there are spaces for five roots for the third molar, which also is not common.

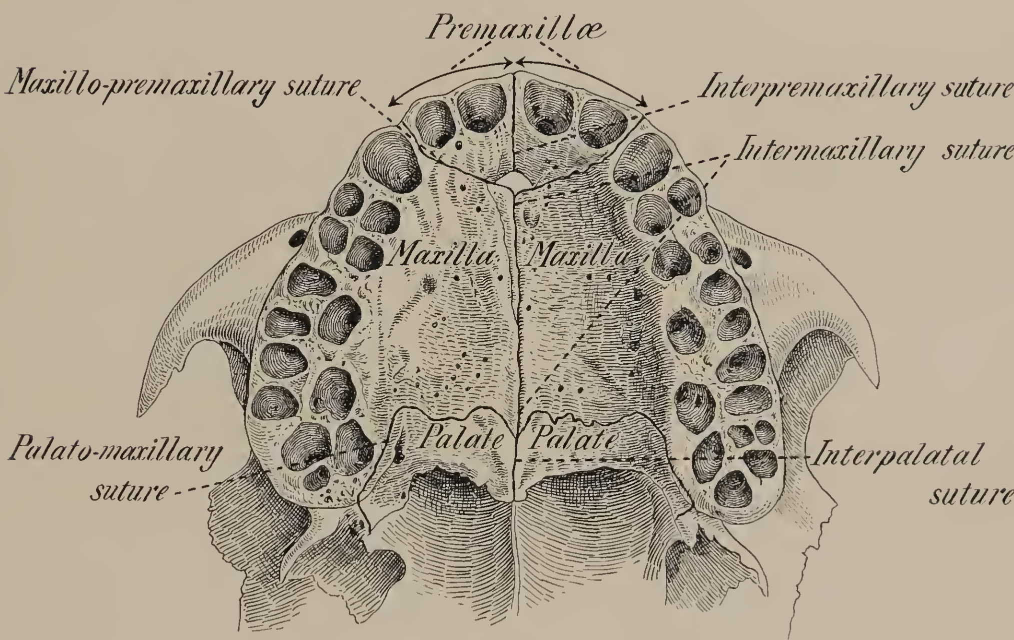


Fig. 74.—View of the palatal surface of the upper jaw, showing the alveoli of the various teeth, and the seven sutures of the roof of the mouth.

STUDIES OF CERTAIN EXTERNAL SURFACES OF THE SKULL.

In order to thoroughly appreciate the differences in the bony anatomy of the face, it is necessary to study skulls and bones considered to be typical at various periods of life.

Front View of Skull.—Fig. 75 represents a front view of a skull, it is nearly symmetrical, presenting the typical anatomy of the external bony structures of the face. There is but the slightest variation in the two sides. It will be noticed that the upper right first molar

stands out slightly more than the left. The septum of the nose is seen to be deflected in the same direction, and upon examination of the

FIG. 75.—Anterior view of the typical skull.

internal structures of the nose it is found that the bulla ethmoidalis is enlarged on the left side, projecting toward the concavity in the

septum. This is an example of what might be taken as quite a constant anatomical law, that when the mouth, palate, and dental arches are

Fig. 76.—Anterolateral view of a typical skull.

bilaterally symmetrical, the outer cranial structures exhibit a like condition.

Fig. 76 is an anterolateral view of a skull giving a good idea of the occlusion of the incisor, canine, and premolar teeth. It also gives a good view of the facial bones and those associated with them. The inner wall of the orbit is well illustrated.

Side View of Skulls.—The following illustrations are taken from various side views of skulls.

FIG. 77.—Side view of typical skull. According to the present nomenclature the bone marked malar should be zygoma and that zygoma should be zygomatic arch.

Fig. 77 shows a side view of a typical Caucasian skull (see mandible in Fig. 2, and base of skull in Fig. 90) which has been taken as the foundation for nearly all studies of the face. The teeth are in typical alignment, shape, and occlusion.

Fig. 78 (see Mandible in Fig. 66, base of skull in Fig. 91) is of a different character. It is taken from the skull of one of the West African tribes. The skull would be classified by nearly all as prognathous. If, however, this man had lived until all of his teeth and their alveolar processes had been lost, it is doubtful if the jaws, especially the lower one, would be considered prognathous.

FIG. 78.—Side view of a West African skull.

FIG. 79.—Side view of a skull belonging to a person of mixed races.

Fig. 79 (see Mandible in Fig. 7, base of skull in Fig. 92) is made from a rather peculiar specimen. In this instance the two jaws are abnormally forward of the typical position. The cranial portion in itself is not of a prognathous character, although the basilar process of the occipital bone is longer than in typical skulls.

Fig. 80 (see Mandible in Fig. 8, base of skull in Fig. 94) is made from a heavy skull, with unusually large, strong jaws and heavy teeth, which are in fairly good occlusion, except that the left second incisors

FIG. 80.—Side view of a heavy skull. (See mandible, Fig. 8; base of skull, Fig. 94.)

are a little out of place. The extraordinary size of the jaws and teeth produces a general appearance of prognathism, but the position of the teeth and their processes does not carry out the idea.

Fig. 81 is a side view of a Chinese skull, showing general roundness. On the left side there is an impacted lower third molar; in the upper jaw of the same side there is no evidence that the third molar ever developed.

Fig. 82 is a side view of a skull (see base of skull in Fig. 96). The occlusion of the six molars and the two premolars, is fairly good, but

FIG. 81.—Side view of a Chinese skull. (See base of skull, Fig. 95.)

FIG. 82.—Side view of a skull. (See base of skull, Fig. 96; also mandible, Fig. 10.)

the rest of the teeth are not in proper alignment, or occlusion, and there is an open bite.

The Base and the Pharyngeal Dome of Nine Skulls.—In these studies the centre of the anterior border of the foramen magnum (the basion) has been chosen as a fixed point from which to make measurements.

The first is taken from the cutting edge of the incisor teeth to the free border of the hard palate.

The second measurement is from the free edge of the hard palate to the anterior border of the foramen magnum.

The third measurement is from the anterior border of the foramen magnum to a vertical line at the posterior part of the skull at the junction of the sagittal and lambdoid sutures.

Fourth, the triangle of the pharyngeal dome is obtained by lines drawn from the free edge of the hard palate (*a*) to the anterior border of the foramen magnum (*b*), from the foramen magnum to the highest part of the basilar process of the occipital bone (*c*) and from that point to the free border of the hard palate (*a*), the height of the dome being from *c* to *d*. (See triangles showing height of pharyngeal dome.)

BASE OF SKULLS AS ILLUSTRATED.

	1st meas. mm.	2d meas. mm.	Total (from teeth to F. magn.) mm.	3d meas. mm.	Total length of skull. mm.	Height of dome. mm.
Fig. 90. Typical skull	58.5	53.5	102	93	195	21.5
" 91. Prognathous skull	69.0	48.0	117	104	221	16.0
" 92. Mixed skull[1]	62.0	48.0	110	95	205	16.0
" 93. Skull	46.0	39.0	85	109	194	22.0
" 94. Heavy skull	64.0	48.0	112	100	212	15.0
" 95. Chinese skull	60.0	40.0	100	94	197	16.5
" 96. Misplaced upper premolars	54.0	38.0	92	105	197	21.0
Prehistoric skull[2]	59.0	42.0	101	61	162	18.0
Prehistoric skull[3]	50.0	45.0	95	61	156	23.0
Difference longest to shortest	(23.0)	(15.0)	(32)	(48)	(65)	(7.0)

[1] The term is here applied to a skull of a mixed parentage.

[2] The measurements of the prehistoric skull of a cliff dweller were obtained through the courtesy of M. Alliot, curator of the Southwestern Museum, Los Angeles, California.

[3] See Fig. 317. Prehistoric skull from Colorado State Museum, obtained through courtesy of Dr. Ketcham.

HEIGHT OF PHARYNGEAL DOME.

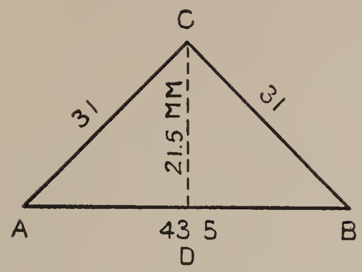


Fig. 83.—Base of skull (90).

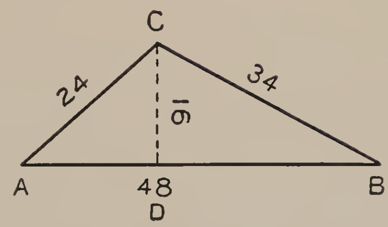


Fig. 84.—Base of skull (91).

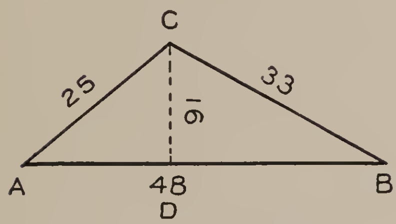


Fig. 85.—Base of skull (92).

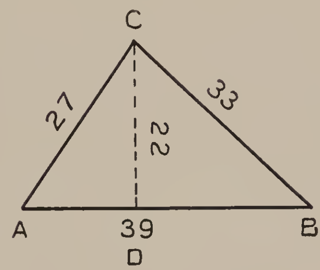


Fig. 86.—Base of skull (93).

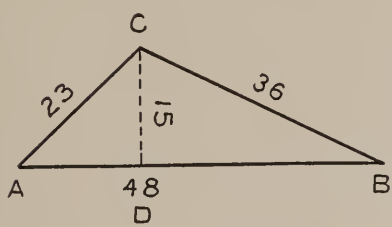


Fig. 87.—Base of skull (94).

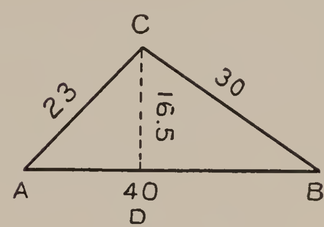


Fig. 88.—Base of skull (95).

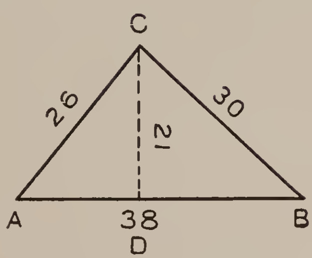


Fig. 89.—Base of skull (96).

Fig. 90 is an illustration taken from the under surface of a typical skull. The relation of the shape, size and position of the upper jaw is in harmony with the rest of the skull, and will be used in comparison with other illustrations of the same general character. The distance from the cutting edge of the incisors to the free border of the hard palate is 58.5 mm.; from the hard palate to the basion, 53.5 mm.; from the basion to the vertical plane of the back part of the skull, 93 mm.; the total length of the skull, 195 mm.

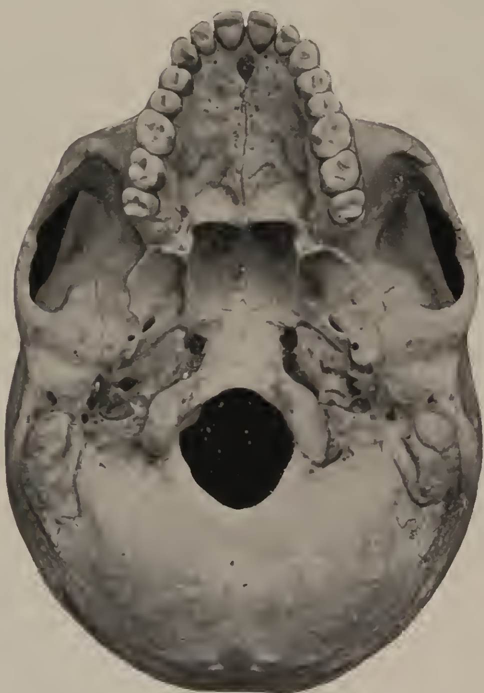


Fig. 90.—Under view or base of the skull shown in Fig. 77.

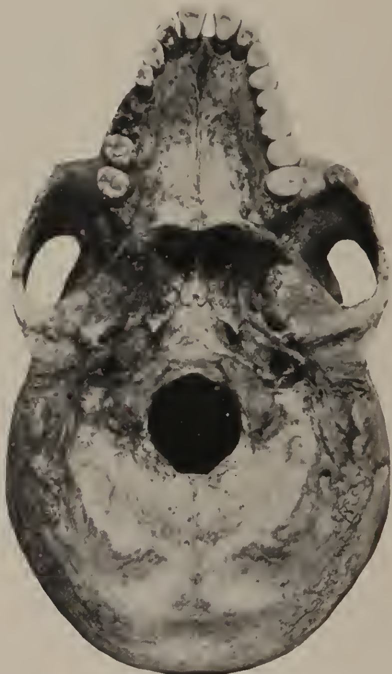


Fig. 91.—Under view or base of the skull as shown in Fig. 78.

Fig. 91 is made from a very prognathous skull (see Fig. 78); it is a great contrast to the one in Fig. 90. The distance from the cutting edge of the incisor teeth to the free margin of the hard palate is 69 mm., a difference of 10.5 mm. between this and the typical skull; from the hard palate to the basion 48 mm., a difference of 5.5 mm.; from the basion to the back point of the skull, 104 mm., a difference

of 11 mm. The total length of the skull is 221 mm., a difference of 26 mm.

Fig. 92 is made from a skull with a prognathous face (see Figs. 7 and 79). Its measurements are as follows: From the cutting edge of the incisor teeth to the free margin of the hard palate, 62 mm.; from the hard palate to the foramen magnum, 48 mm.; from the anterior border of the foramen magnum to the back of the skull, 95 mm.; total length of skull 205 mm.

Fig. 92.—Under view or base of the skull as shown in Fig. 78.

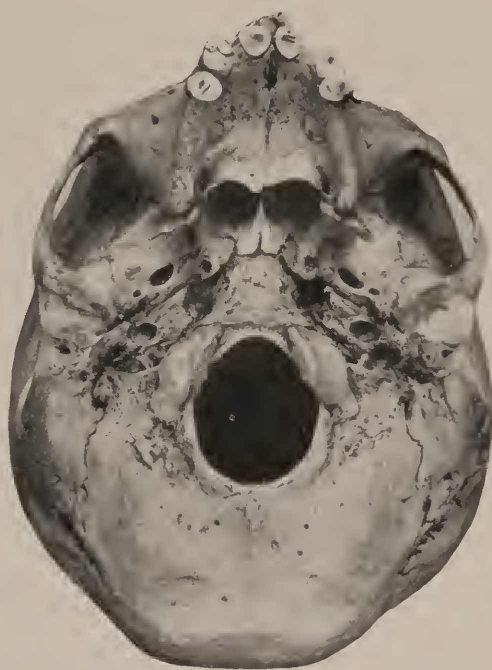


Fig. 93.—Under view or base of a very short skull as shown in Figs. 363, 364 and 365.

Fig. 93 is made from a very short skull. The distance from the incisor teeth to the free border of the hard palate being 46 mm.; from the hard palate to the foramen magnum, 39 mm.; from the basion to the back of the skull, 109 mm.; total 194 mm. The unusual height of the pharyngeal dome is 22 mm., this measurement indicates the foreshortening of the face; Fig. 96 has a short face also. The most

important feature of this picture is that, on the left side, it shows evidence of three different points of articulation of the condyloid process described under Figs. 363, 364 and 365.

The prehistoric skull, Figs. 314 and 317, has the highest pharyngeal dome, 23 mm., and the shortest skull, 156 mm., that has come under the author's notice.

Fig. 94.—Under view or base of a very heavy skull as shown in Figs. 8 and 80.

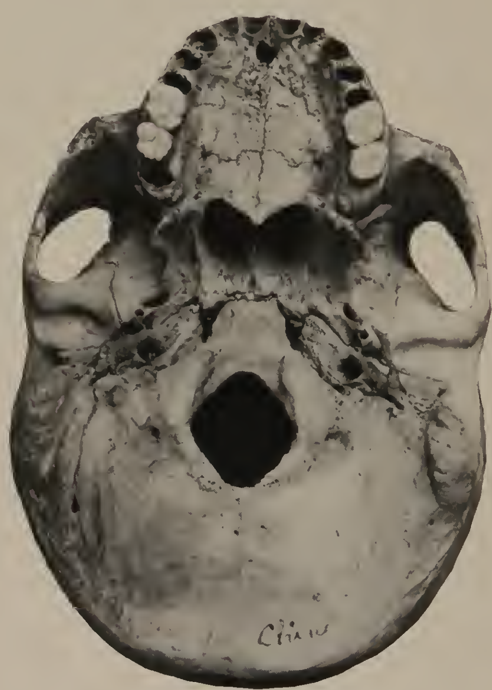


Fig. 95.—View of the base of a Chinese skull, showing a general roundness of form.

Fig. 94 is made from the base of a very heavy skull (see Figs. 8 and 80) with the following measurements; from the cutting edge of the incisors to the free border of the hard palate, 64 mm.; from the hard palate to the foramen magnum, 48 mm.; from the basion to the vertical plane of the back of the skull, 100 mm.; total length of skull, 212 mm.

Fig. 95 shows the base of a Chinese skull; it is short and round, measuring from the cutting edge of the incisor teeth to the free margin

of the hard, palate 60 mm.; from the hard palate to the foramen magnum, 40 mm.; from the basion to the posterior part of the skull, 94 mm.; total length of the base of the skull, 197 mm.

Fig. 96 is made from the under surface of a skull in which there is a slight anterior occlusion and open bite (see Figs. 10 and 82). The distance from the cutting edge of the incisor teeth to the free border of the hard palate is 54 mm.; from the hard palate to the anterior

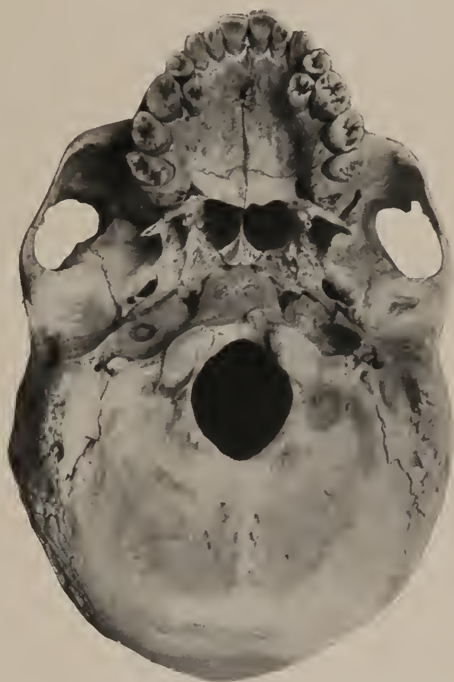


FIG. 96.—Under view of a skull where there are two misplaced premolars.

border of the foramen magnum, 38 mm.; from the basion to the vertical plane of the back of the skull, 105 mm.; total length of the skull, 197 mm. It is evident that in this skull the principal cause of anterior occlusion is the short distance (only 92 mm.) from the cutting edge of the incisor teeth to the hard palate and the foramen magnum, this is 10 mm. shorter than typical and its pharyngeal dome is high.

It will be noticed that two of the premolars are out of line, caused also by the smallness and shortness of the whole upper jaw. An additional cause of the anterior occlusion is that the angle of the mandible is unusually obtuse, measuring 135°. If correction were made by slowly forcing the upper premolar teeth into position, it should lengthen the arch, which would assist in improving the position of the anterior teeth. The fault of the lower jaw is at the angle.

GENERAL COMPARISONS BETWEEN THE WIDTH OF THE UPPER DENTAL ARCH, THE FLOOR OF THE NASAL FOSSA, AND THE SIZE OF THE MAXILLARY SINUS.

There is a general impression that a narrow dental or palatal arch will be associated with a correspondingly narrow nasal floor, but examination of a large number of skulls does not confirm this premise. There are many skulls having wide palatal arches that are accompanied by narrow nasal floors, and also many skulls in which the arch is narrow while the floor of the nose is wide.

Roughly speaking the upper jaw in the region of the inferior meatus of the nose may be divided horizontally into four sections—two maxillary sinuses and two nasal cavities, if the latter are abnormally narrow, the sinuses will be comparatively wide, and *vice versa*, when the sinuses are small or undeveloped, the nasal cavity will be wide even to the extent of passing over the alveolar process and the roots of the teeth.

A few illustrations are shown in which the measurements of the upper dental arch have been taken between the outer surface of the first molar teeth, and the width of the floor of the nose measured at a corresponding point in the same plane (Figs. 97 and 98), are from typical skulls, without any marked irregularities. In both of them the width of the floor of the nose is about one-half that of the dental arch.

Fig. 97 is a vertical transverse section of a typical skull, showing good symmetrical arrangement. The dental arch measured 58 mm., while the width of the nasal cavity is about half, or 29 mm. In other

Fig. 97.—Vertical transverse section of typical skull.

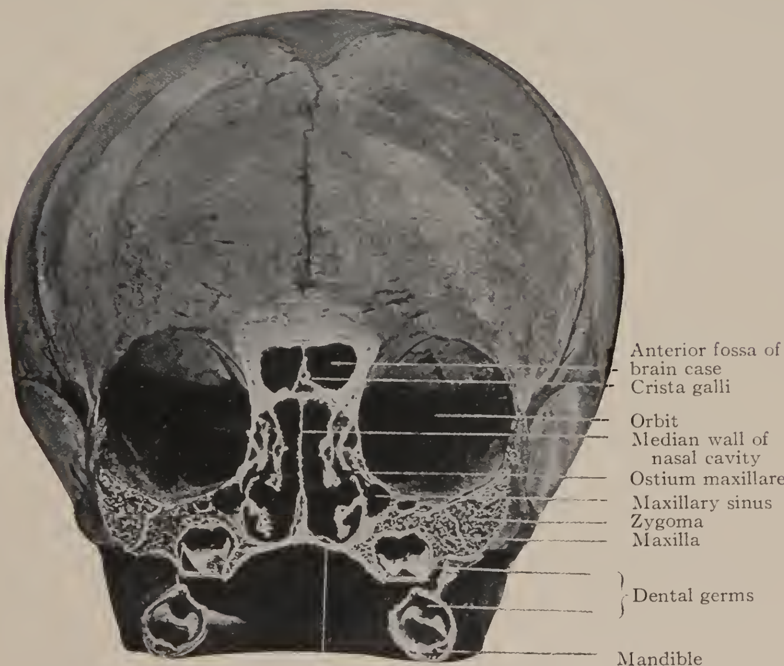


Fig. 98.—Transverse section of child's head at birth.

typical skulls about the same relative measurements may be found, *i. e.*, the width of the arch is about twice that of the floor of the nose.

Fig. 98 is made from the skull of a child at birth, showing the same relative measurements.

Fig. 99 shows an arch of 70 mm. in width, while the floor of the nose is only 26 mm. wide.

Fig. 100 is made from a skull with a very narrow dental arch and a very wide floor of the nose. The dental arch measures 35 mm. The floor of the nose, which should be 27.5 mm., is 35 mm.

Fig. 99.—Wide arch, narrow nose.

Fig. 101 is made from a skull with a very wide arch and a narrow, compressed nose. The measurement of the arch is 66 mm. The nose should be 35 mm., but is only 20 mm. It will be noticed that the maxillary sinuses are very large, which as before stated, is usually the case where the nose is narrow.

Fig. 102 is made from a skull showing a very narrow arch. The width across the outside of the second premolars is but 44 mm., while the floor of the nose measures 35 mm.

Fig. 100.—Shows narrow arch and wide floor of nose.

Fig. 103 is from a vertical transverse section of a skull just in front of the first molar teeth, looking forward. The arch is of good width, though narrow at the top, the measurement over the premolars being

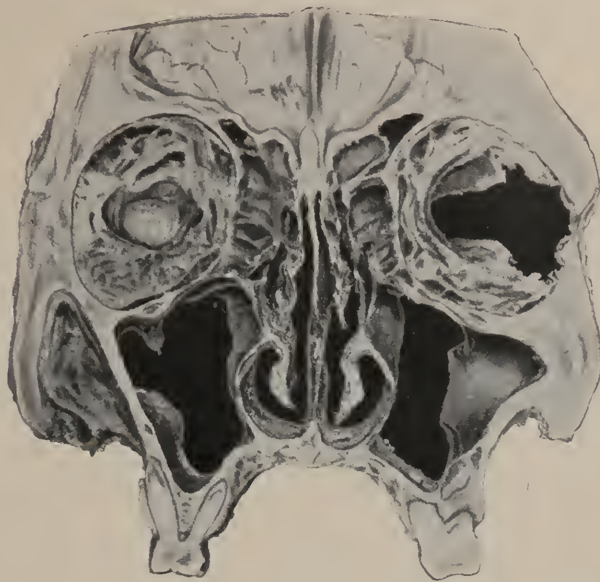


FIG. 101.—Shows wide arch and narrow floor of nose and large maxillary sinuses.

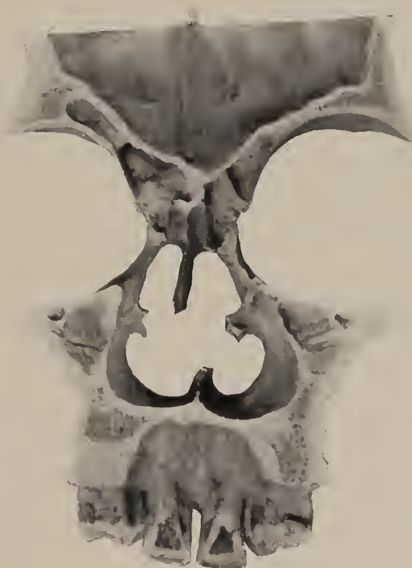


FIG. 102.—Shows very narrow arch and wide nose.

55 mm. The floor of the nose measures about 20 mm., and the widest portion of the nose is 32 mm. There are unusually large maxillary

FIG. 103.—Shows unusually large maxillary sinuses.

sinuses, with a correspondingly narrow nasal cavity. Before the sinuses were cut, each held one fluidounce and a quarter (about 35 c.c., or together 70 c.c.). At the point of the section the two antra

FIG. 104.—Posterior section made from Fig. 103.

are but 19 mm. apart, as they virtually pass under the nasal cavity. In the region of the first premolar teeth, the distance between the two antra is about 13 mm.

Fig. 104 is a posterior section from the same specimen as Fig. 103.

Fig. 105 is an anterior view of a vertical transverse section showing small maxillary sinuses and the nasal cavity extending outward to the external portion of the maxillæ.

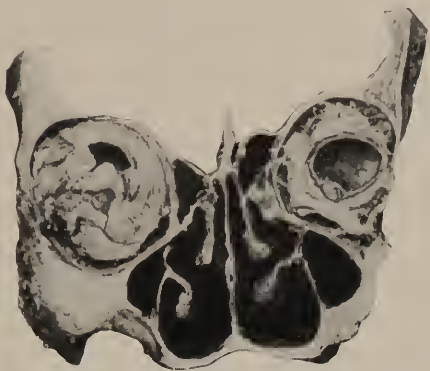


Fig. 105.—Shows small maxillary sinus.

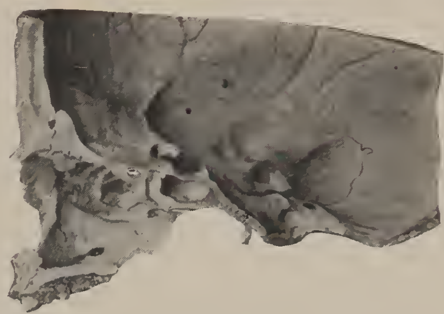


Fig. 106.—Shows nasal cavity extending over the alveolar process.

Fig. 106 is from a skull in which the nasal cavity extends outward over the alveolar process until the palatal roots of the first and second molars appear in the floor of the nasal cavity.

CHAPTER V.

THE MOUTH.

The mouth commands attention by its great importance when we consider its many functions. Under normal conditions it is the gateway through which all food enters for the nourishment of the body. It is the seat of the organs of taste and the workshop wherein are carried on the functions of mastication, insalivation, and the preparation of food for the digestive apparatus. It is also the portal through which more or less of the air received into the lungs passes.[1]

The mouth, or buccal cavity, occupies the space between the upper and lower jaws (see Fig. 37). It is divided into two portions—the vestibule and the mouth proper.

The vestibule (see Fig. 37) is a narrow, curved space having two walls, an outer and inner. The outer wall consists of the lips and cheeks, which are lined by mucous membrane containing the labial and buccal glands; the duct of the parotid gland has its opening in this membrane about opposite the second maxillary molar. The inner wall is composed of the teeth, alveolar process, and portion of the upper and lower jaws. The bone is covered by a mucoperiostium containing small mucous glands; the upper portion of the alveolar process is covered by gum tissue.

The mouth proper can be divided into roof, sides, floor, and outlet. The roof is composed of hard and soft palate; the hard palate has for its base three pairs of bones: two premaxillary, two palatal processes of the maxillæ, and the horizontal portions of the palatal bones; the union of these bones forms seven sutures, for description of which see page 78. The soft palate is composed of several muscles, see general anatomy for description.

[1] Taken from an article by the author in Musser and Kelly's Hand-book of Practical Treatment, vol. iii, p. 286.

The hard and soft palates are covered by a continuous mucous membrane extending from the vestibule, passing between the teeth, to the free edge of the soft palate. The portion covering the bone is in close relation to the periosteum, and is called the mucoperiosteum of the hard palate. It is a strong fibrous covering and contains a large number of palatal mucous glands, the secretion of which aides in deglutition.

The sides of the mouth proper are composed of teeth, maxillary and mandibular, the gum tissue, the alveolar processes of both jaws, and all that portion of the mandible above the attachment of the mylohyoideus. The alveolar process and the true bone are covered by mucoperiosteum. The floor of the mouth contains the tongue and is composed principally of the mylohyoid muscle. The outlet of the mouth is the oropharyngeal opening, for anatomical description see general anatomy.

Besides the general mucous glands of the lining of the mouth, the ducts of the submaxillary and the sublingual glands have their opening near the frenulum linguæ.

THE TEETH.

In studying the anatomy of the teeth, one finds quite as many variations occurring, as exist in all of the other structures of the body. Adami makes the statements that "there is no absolute standard of either structure or function in any one species," "every individual varies in every particular from every other individual." It was also stated by the author in 1901, in the preface to the first edition of this book that "there is doubtless a typical or typal form for each bone, but it is not often found in nature. If we were to photograph a thousand temporal bones for example, the composite of the entire number would properly be accepted as figuring the typal temporal;" in the same way, if photographs could be made of a thousand molars, the composite picture should give the type of a molar tooth which could be taken as standard in studying that particular tooth; it follows of course that this "type" can only be used as a basis for the practical study of the

variations as to size, shape, color of enamel, etc., which are presented by every individual.

The teeth are situated in the mouth at the commencement of the alimentary canal. In man they are equally divided into maxillary and mandibular teeth. They are of dermoid origin and commence development in early embryonic life. The principal functions are cutting, masticating and preparing food for digestion. They also assist in articulate speech.

Man has two sets of teeth, deciduous and permanent. The deciduous set is composed of twenty teeth of the following formula.

DECIDUOUS SET.

$$\text{Incisors}\left\{\begin{array}{ll}\text{Maxillary} & 4\\ \text{Mandibular} & 4\end{array}\right.\qquad \text{Canines}\left\{\begin{array}{l}2\\ 2\end{array}\right.\qquad \text{Molars}\left\{\begin{array}{l}4\\ 4\end{array}\right.\qquad \text{Total, } 20$$

THE PERMANENT SET.

$$\text{Incisors}\left\{\begin{array}{ll}\text{Maxillary} & 4\\ \text{Mandibular} & 4\end{array}\right.\qquad \text{Canines}\left\{\begin{array}{l}2\\ 2\end{array}\right.\qquad \text{Premolars}\left\{\begin{array}{l}4\\ 4\end{array}\right.\qquad \text{Molars}\left\{\begin{array}{l}6\\ 6\end{array}\right.\qquad \text{Total, } 32$$

The eight incisor teeth are situated in pairs on either side of the median line of the mouth, the upper ones are in the incisive or intermaxillary bone, the lower ones in the mandible, these teeth are known as first and second maxillary and mandibular incisors respectively.[1]

The maxillary canine teeth are situated in the anterior portion of the alveolar process of the true maxillæ. The mandibular canines are next to the second incisors in the mandible.

The deciduous molars, first and second, are posterior to the canine teeth. The eight premolars, permanent set, are situated in pairs anterior to the molars, on either side, both in the maxillæ and mandible.

The perminent molars, first, second and third are the last teeth on either side in the maxillæ and the mandible and have no deciduous teeth preceeding them.

In a general way the anatomy of a tooth consists of four parts, the crown, neck, roots, and pulp.

[1] The writer prefers the nomenclature used by general scientists and comparative anatomists, and will speak of first and second incisors rather than "central" and "lateral," "canine" rather than "cuspid" and "premolar," rather than "bicuspid," "anterior" and "posterior" faces or cusps instead of "mesial" and "distal."

The crown, in normal condition, is that portion extending through the gum tissue and is the first part of the tooth formed. Its outer portion is covered with enamel, the body under the enamel is composed of dentine within which is the pulp chamber, containing the body of the pulp.

The neck of the tooth is the constricted portion between the crown and the root, it is at this point that cementum of the root joins the enamel of the crown.

The root of the tooth is that portion which is held within the alveolar process by the assistance of membranous tissue. Its outer portion is covered by cementum under which is a continuation of the dentine of the crown. The number of roots varies according to the teeth; single crown teeth such as incisors and canines usually have but one root, though there are exceptions to this rule, especially in the canines. The roots of the other teeth generally follow the number of cusps in the crown.

The pulp is that portion of the tooth found within the pulp chamber and the pulp canals. Its shape generally at maturity is a miniature of the crown and roots.

Anatomy of the Permanent Teeth.—INCISORS.—Eight in number. The four maxillary incisors are situated in the intermaxillary bone, two on either side of the median line and are named right and left, first and second incisors, they are so similar that one description will answer for both.

The crowns are somewhat wedge- or chisel-shaped, being much wider at the cutting edge than at the neck and are somewhat thicker at the base, sloping to a thin, sharp-cutting edge for biting and cutting the food, when these teeth are first erupted the edges are indented, but they are soon worn smooth.

The labial face of the crown is slightly convex from the cervical margin to the cutting edge, and also in a transverse direction. It usually has two very shallow depressions running from the cervical margin to the cutting edge of the tooth which divides the surface into three slight lobes. Where the labial surface joins the neck it is semicircular in form.

The cutting edge is not quite at a right angle with the longitudinal axes of the tooth. The anterior corners are slightly pointed and the cutting edge slopes backward and slightly upward joining the lateral sides of the crowns in a curved manner. This curve is more marked in the second incisors than in the first.

The palatal face is narrower than the labial, which allows the better adaptation of the teeth to the dental arch. This face is markedly concave, both in length and width; very often there is an increase in size near the upper margin, making a small cusp known as a cingulum; between this and the cutting edge there is often a small pit which makes a predisposing cause of decay, this is more frequent in the second incisor than in the first. Where the palatine face joins the neck of the tooth it is convex in form.

The anterior (proximal) face, or that portion facing the incisor of the opposite side, is triangular in shape. The base of which is concave and joins the neck of the tooth, from the labial and palatine margin of this face the lines of the wedge slope toward each other, forming a prominent point, this face is convex in both directions.

The posterior, lateral face is very similar to the anterior face, except it is shorter and more convex, terminating in a rounded corner.

The cervical margin of the labial and palatine faces of the crown is convex while the lateral portion is concave.

The first incisor is larger than the second, and is more regular in shape. The second incisor is more apt to be abnormal in shape. It is occasionally lacking in the denture, and on the other hand, there may occasionally be a third incisor (see Fig. 340).

The neck of the incisors is somewhat constricted, showing the union of the cementum covering the root, with the enamel covering the crown. In a transverse section the neck is rather oval in outline with the labial surface a little wider than the palatal. The lateral edge slightly overlaps the root, which causes a better fitting of the tooth in the gums.

The root of the incisor is long, single and cone-shaped, somewhat flattened transversely. The root of the first incisor is larger than that of the second. The root of the second is more flattened and is liable to be slightly curved backward near the apex.

The pulp chamber and its pulp canals generally resemble the tooth in miniature, though in some cases a compressed root may have two or more pulp canals passing to the apices of the roots. This is important to know when diseased canals are to be treated. Another important feature of the pulp chamber of a tooth is that it is comparatively large in youth, becoming smaller as age advances.

Canine Teeth.—Four in number, two maxillary and two mandibular. The two maxillary canines are situated in the anterior portion of the alveolar process of the true maxillary bone, posterior, laterally, to the second incisors. The architectural features of the canine, together with its firm osseous surrounding make it a very important and powerful tooth. Its root is longer and stronger than that of any other tooth. Its size and position make it of great importance to the facial expression, it assists in producing the canine eminence also the canine fossa of the facial bones. Its loss is indicated by depressed lines of the face which generally indicate "old age." This tooth is very seldom omitted in its development, though it is very often misplaced. It is the opinion of the writer that it is the second tooth in frequency of impaction. The third mandibular molar being the first. The canine is usually erupted after the second incisor and first premolar, and its normal position is often encroached upon by these teeth. The crown of the canine tooth has four irregular, flattened faces.

The labial face is spear-shaped with base joining the neck of the tooth in a convex form. Passing from the base there is a prominent ridge extending to the point of the crown which divides the face into two unequal parts, the anterior portion being narrower than the posterior; on each side of the ridge is a slight depression dividing the labial surface of the tooth into three lobes, the middle lobe being much the largest.

The palatal face is spear-shaped and is beveled from the base to the cutting edge. At the centre of the base there is usually a cingulum from which a ridge extends to the cutting edge, dividing the face into two portions. There are also two lobes or elevations on the outer and inner margins of the face, which with the central ridge forms a depression on each side.

The anterior and posterior faces are similar to those of the first incisor. Where the posterior edge joins the cutting edge there is considerable enlargement, making the neck appear narrow.

The cutting edge of the crown tapers to a blunt point which projects somewhat below the other teeth and is divided into two unequal parts; the anterior, which is the shorter, occludes with the posterior surface of the mandibular canine; the posterior portion occludes with the anterior surface of the first mandibular premolar.

The neck, in transverse section, is a flattened oval, the curvature on the labial surface being larger than on the lingual.

The root, which is longer and stronger than those of the other teeth is a flattened cone, with a slight curve pointing backward.

The pulp and its canals generally resemble the tooth in miniature.

Premolar Teeth.—The premolar teeth are eight in number, four in the maxillæ and four in the mandible.

The maxillary premolars (upper bicuspids) are posterior to the canine teeth and are seldom omitted in their development, occasionally, however, while the deciduous molar may develop normally, the premolar that should follow it, will not be present (see Fig. 328). There are several cases on record where three premolars have been formed on each side of the maxilla and mandible, and one case has come under the writer's observation where there are four premolars on each side of the mandible (see Figs. 343 and 344).

The premolar teeth are sometimes spoken of as double teeth, but their appearance is more like two canines fused together.

The first maxillary premolar is usually larger than the second.

The crown is cuboidal and has five faces, the buccal, palatal, anterior, posterior, and morsal.

The buccal face is very similar to that of the canine tooth. It is spear-shaped, with the base joining the neck of the tooth in a curved form.

Passing from the base there is a prominent ridge extending to the point of the spear-shaped cusp which divides this face into two unequal parts, the anterior portion being the narrowest; on each side of the ridge there is a slight depression, making three lobes, the middle lobe being much the largest.

The palatal face is very similar to the buccal, differing in size, being narrower and shorter.

The anterior and posterior faces are generally similar, being convex on the upper portion of the face and slightly concave near the neck, these faces slope inward on passing toward the neck, making the crown much narrower at this point, and helping to make an inverted V-shaped space between the premolar and the adjoining teeth.

The morsal face consists of two cusps with two connecting ridges, anterior and posterior; between the labial and palatal edges of the cusps, there is a sulcus somewhat in the form of a letter H. This formation makes a weak place in the enamel of the crown, which gives a predisposing cause of caries.

The neck is a compressed oval somewhat wider on the buccal face.

The first premolar usually has two roots. The root of the second premolar may be bifurcated, but it is usually single, with two pulp canals; sometimes there is a bifurcation near the apex.

The pulp chamber and its pulp canals, under ordinary circumstances, is a miniature of the premolar tooth.

The Second Maxillary Premolar.—The description of the first premolar will answer for the second, except that the second is usually smaller, with but one root, but it must be remembered in the treatment of this tooth that occasionally it may have two roots and also that the first premolar may have but one root.

Molar Teeth.—The molar teeth are twelve in number, six in the maxilla and six in the mandible. These teeth have no predecessors as have the other twenty permanent teeth. They are situated on each side of both jaws, and with more or less variation, erupt at different periods. The first molars about the sixth year, the second from the twelfth to thirteenth year, and the third from the seventeenth to the twenty-third year or even later. The first molar takes its position in the posterior portion of the alveolar process; as the jaws develop they usually make room for the other two molars. At times the jaws do not seem to grow sufficiently to allow proper eruption to take place; in these cases, the third molar is sometimes impacted or misplaced. It also occasionally happens that the third molar does not develop at

all; again, there may be a rudimentary fourth molar sometimes called a supernumerary third molar.

When these teeth are in typical occlusion, the six mandibular molars articulate with the maxillary molars and the posterior half of the maxillary second premolars. As they are situated near the fulcrum of the mandibular articulation, and are in close proximity to the attachment of the powerful muscles of mastication, they are in position to receive the full force of these muscles for crushing and grinding the food.

The maxillary molar teeth are situated in the alveolar process immediately below the maxillary sinus. In the Caucasian race the alveolar process is shallow, the roots of the molar teeth are spread apart and pass into the outer and inner walls of the sinus (see Figs. 37 and 97). The molar teeth in this position are liable to produce pathological conditions in the sinus. In the lower type of man the alveolar processes are much deeper, and the molar roots do not enter the walls of the sinus (see Fig. 200).

The crowns are somewhat cuboidal in shape, with five faces, the buccal, palatal, anterior, posterior, and morsal.

The buccal face is nearly twice the size of that of the second premolar, its general appearance is that of two fused premolar teeth having the cusps very marked. The anterior buccal cusp was called by Harrison Allen the "canine cusp." In his "Facial Region" he also stated that "Since the cusps exist before the roots, the latter may be said to be conformed to the cusps. So that to every cusp there is a tendency to form a distinct root. It is best, therefore, to study the teeth by their cusps."[1] Following this plan, the cusps indicate the general character of the tooth, whether it be a single, double or multicusped tooth.

First Maxillary Molar.—As said before, the buccal face has the appearance of two premolars fused together. The centre of this face is convex, sloping as it approaches the neck of the tooth. From just below the centre, a perpendicular groove commences, deepening as it passes toward the morsal edge, thus making an anterior and pos-

[1] J. B. Lippincott Co. Press, p. 111.

terior buccal surface of the cusp, the edges of which meet the anterior and posterior surfaces in a curved manner.

The palatal face is convex, having a small fissure about one-third from the posterior edge, passing downward to the occluding surface of the tooth, which joins the posterior fissure of the morsal face.

The anterior and posterior faces are generally convex in both directions, sloping downward to the masticating edge in a rounded manner and curving upward toward the neck of the tooth.

The morsal face is divided into four cusps. The anterior buccal, or canine cusp, is very much the shape of a canine tooth, hence the name; the posterior buccal, or molar cusp, is usually about the same size, though not quite so pointed. The anterior palatal, or premolar cusp, is very much larger and more rounded than the canine cusp. The posterior palatal cusp, the cingule, is small and forms a rather prominent corner or pillar to the tooth. Between the three main cusps there is an irregular surface; between the two palatal cusps is a deep sulcus which forms a predisposing place for caries.

The neck in transverse section is rhomboidal in shape, with rounded corners; the buccal face is wider than the palatal as it forms the base for the two roots. The palatal face of the neck is more rounded than the buccal and forms the base for the large palatal root, which is usually single.

The roots are three in number, two buccal and one palatal, they are usually well separated at their upper ends. The anterior buccal root is rather flattened and may have two pulp canals within it. The posterior buccal root is rounded, usually having but one pulp canal. The palatal root is larger and rounded, having but one pulp canal, which is usually straight and large as compared with the others, and therefore of easy access.

The second maxillary molar is usually similar to the first, when differences exist, it is in the shape of the crown and the divergence of the roots. The crown is somewhat smaller than the first molar and is often triangular in outline. The cingulum is generally much smaller and consequently the premolar (anterior palatal) cusp is larger, which gives a large, smooth surface to the palatal face. The

fissure between the cingulum and the premolar cusps is not so deep, and consequently not so prone to decay. The anterior and posterior faces differ from each other; the anterior face is usually more flat while the posterior face is quite oval, especially when the third molar is small or missing, in the latter case it is liable to be quite rounded as a "finishing tooth."

The neck is similar to the neck of the first molar, varying only in proportion to the various shapes of the crowns.

The roots are generally the same in number though varying in size, they are also generally close together, due to the fact that the posterior root of the first molar is occupying more or less of the space which the anterior root of the second molar might have taken.

The size of the maxillary sinus may influence the position and shape of the roots of the molar teeth (see Fig. 199).

The third maxillary molar is more varied in its shape than any of the other maxillary teeth; it may be large or small, may have a small cingulum cusp with a single root (called a peg tooth), or it may have many cusps with a corresponding number of roots, which may be straight or curved.

If the pulp becomes diseased it is most difficult to treat, and for this reason the maxillary third molar has been classed by some as the pathological tooth of the mouth.

Mandibular Teeth.—The mandibular teeth are the active organs of mastication, in as much as they are fixed in the mandible which is acted upon by the temporalis, masseter, pterygoideus, externus and internus muscles (see Fig. 300). These muscles give the lower jaw power of protrusion, retrusion, and side-to-side movement (see Mandibular Articulation, page 68), which in turn together with the depressor muscles of the mandible, enable the teeth to cut, tear, and grind food. The lower anterior teeth come in contact with the upper fixed teeth, striking the cutting edge, then coming against the under concave surface of the upper anterior teeth in a general motion similar to that of a pair of shears, provided the upper blade of the shears were fixed.

The posterior mandibular teeth meet the upper posterior teeth in both grinding and crushing motions.

The two first right and left incisors are situated on either side of the symphysis. They are the smallest teeth in the mouth. The first maxillary incisors are much wider, as they not only cover the first mandibular incisors, but extend over one-half the second mandibular incisors, thus "breaking the joint." This breaking of the joint is carried on between the maxillary and mandibular teeth throughout the balance of the jaws until the third molars are reached. The third maxillary molar occludes only with the third mandibular molar.

The crown of each first mandibular incisor has four faces and a cutting edge.

The labial face is slightly convex in both directions. It is broadest at the top or cutting edge, which is straight.

The face becomes narrow toward the cervical portion, which is convex.

The lingual face is slightly convex from side to side and concave perpendicularly.

The lateral faces are concave and wedge-shaped with the point of the wedges at the top or cutting edge and the base at the neck of the tooth.

The neck is small, and in a transverse section, is a slightly compressed oval.

The root is not so long as the second incisor root, and is usually straight and somewhat flattened with but one pulp canal.

The pulp chamber and its canal is of the same shape as the tooth, only very much smaller.

The second mandibular incisors are similar to the first only somewhat longer and larger. The cutting edge is much wider, and the posterior face tapers into the neck of the tooth. The root is of the same general outline as the first incisor, only larger and longer.

The mandibular canine, right and left, is similar to the maxillary canine, the architectural plan is on the same general lines with the strongest point at the neck (see transverse section, Fig. 114). This tooth is the least prone to decay of all the teeth.

The crown has four faces. The labial face is convex both horizontally and vertically; it is broader at the cutting edge, which is divided

into two portions like a spear point, the posterior portion being the longest; occasionally there are two slight grooves passing vertically from the cutting edge to the base of the crown which is convex.

The lingual face is in a general way concave from the cutting point to the neck; there is a slight central ridge curving to a groove on each side of the tooth.

The anterior face (mesial) is broader than the posterior. The posterior face is wedge-shaped with the base at the neck. Commencing at the cutting edge the face slopes toward the neck, which is narrow, leaving a considerable space between the canine and the first premolar.

The neck (see Fig. 114) is much larger than that of any of the teeth except the molar; it is wider at the labial surface than at the lingual.

The root is the longest of any of the lower teeth, sometimes extending below the general line of the mandibular canal (see Fig. 161). Occasionally this tooth has two roots and at times in the single root there may be two pulp canals.

Mandibular Premolars. — The first mandibular premolars are situated just posterior to the canines, they are usually smaller than the second premolars. The crown of each tooth has five faces; the buccal face is similar to that of the canine and is named by Harrison Allen, the canine cusp; it has a slight ridge passing from the spear point down to the base, which is convex and there are two slight grooves on each side of the ridge which might be said to divide the face into three lobes.

The lingual face is convex horizontally and nearly straight perpendicularly, sloping to a narrow, convex base. The lateral faces are also convex horizontally, they slope inward toward the centre of the tooth, making the neck narrow, with inverted V-shaped spaces between it and the canine and the second premolar.

The morsal face varies in different teeth. There are usually two marked cusps: the canine cusp on the buccal side, and the premolar on the lingual side; running from the outer and inner faces of the cusps are ridges of enamel, somewhat elevated in the centre, forming smaller cusps; between these four cusps are two pits or sulci which make predisposing points for caries.

The neck is a compressed oval, smaller on the lingual edge, than on the buccal.

The root, usually single, is long, flattened and comparatively straight, but at times, as the number of cusps indicates, the root may be composed of two or more divisions.

The pulp chamber, and its canals, in early life, is generally a miniature of the tooth, the number of pulp canals corresponding to the number of cusps.

The second mandibular premolars are situated between the first premolars and the first molar teeth. In a general way the description of the first premolar will answer for the second except that it is usually larger.

The morsal face of the crown differs somewhat in the arrangements of the cusps, in some cases it might be called tricusped.

The neck of the tooth is a little larger than that of the first premolar.

The root is usually single, but occasionally it is flattened and divided. In rare cases there are three roots (see Fig. 122).

The pulp chamber is practically the same except that there may be several pulp canals.

Mandibular Molar Teeth.—The mandibular molar teeth are situated in the posterior portion of the body of the mandible immediately over the canal which contains the mandibular nerve and vessels; any disturbance, pathological or mechanical, in this region, is liable to cause serious conditions, such as impacted teeth, neuralgia, reflex nervous disturbances, sometimes only local, but often reaching into the general nervous system.

These teeth have no predecessors and erupt one after another as the body of the bone grows sufficiently to make room for them. When this room is not adequate, the third molar or even the second molar is liable to become impacted or misplaced, causing more or less serious complications.

The first mandibular molar is situated posterior to the second premolar. In correct occlusion, it articulates with the posterior portion of the morsal face of the second maxillary premolar and the anterior portion of the morsal face of the first maxillary molar.

The crown is of an irregular cuboidal form, with a greater width anteroposteriorally than buccolingually. It has five faces: buccal, palatal, anterior, posterior, and morsal.

The buccal face is usually convex in all directions; it is divided into three columns by two rather deep grooves, the buccal and posterior. The buccal groove occasionally passes down through the face, but usually terminates midway in a pit, which acts as an inducement for decay, the morsal edge is divided into three points, which help to form three buccal cusps.

The lingual face is rounded and smooth. There are seldom any fissures on this surface which make it quite free from caries. The morsal edge terminates in two points, which assist in forming two lingual cusps, the fissures between these two elevations is somewhat prone to decay.

The anterior and posterior faces are flattened perpendicularly, the upper border is convex and as the face passes downward toward the neck it becomes flattened. These faces are inclined inward, making an inverted V-shaped space between this molar and the premolar, also between the first and second molar.

The morsal face is the largest face of any of the teeth and is divided into five cusps, two buccal, two lingual and a posterior cusp. The anterior buccal cusp is very much the shape of the canine crown, and is the largest and most prominent cusp. The median buccal cusp (the molar cusp) is usually somewhat smaller than the canine cusp. The two inner or lingual cusps are nearly the same size. The fifth cusp, which is in the posterior portion of the crown, is small and sometimes spoken of as the cingulum of the tooth.

The fissures pass in various directions and at the confluence or sulci, the enamel is not usually perfect which makes the crown prone to decay at these points.

The neck is square in outline, much depressed on the buccal and labial side, near the place where the root divides. The anterior margin of the neck is slightly concave, where the root begins to flatten on its surface. The posterior margin of the neck is usually convex, matching the posterior face of the root which seldom bifurcates.

The roots are two in number, usually well separated near their points. The anterior root is quite flattened and concave transversely, it is more inclined to bifurcate than the posterior root; the pulp of the bifurcated root separates into two divisions, one in each root canal, making this root difficult to treat.

THE MANDIBULAR SECOND MOLAR is situated between the first and third molar; it articulates with the posterior portion of the morsal face of the first maxillary molar and the anterior portion of the morsal face of the second maxillary molar.

The crown is nearer a cube than the first and third molars, *i. e.*, is nearly of the same length and breadth and has five faces: buccal, palatal, anterior, posterior, and morsal.

The buccal face is usually convex in both directions. On its upper morsal edge it is divided into two portions, helping to form the anterior, canine, and posterior, molar cusps. Sometimes at the base of this division a fissure commences and passes down the centre of this face to a pit, this induces decay of this part. The upper half of this face inclines inward, allowing the buccal cusps of the first and second maxillary molars to overlap the crown.

The lingual face is rounded or convex in all directions. On its morsal edge it is divided into two lingual faces, the anterior and posterior cusps; on its lower margin it is concave near the commencement of bifurcation of the two roots.

The anterior and posterior faces are similar to those of the first molar, the anterior being somewhat convex in the upper portion and concave in the lower; the posterior face is more convex than the anterior.

The morsal face is usually divided into four cusps; occasionally there is a cingulum giving it five cusps. At the base or confluence of these cusps there are irregular fissures or sulci, the enamel not being well formed or joined together at these points makes them prone to decay.

The neck in cross-section is a square in outline with concave depressions on the sides.

The roots are two in number, flattened anteriorally and posteriorally with a strong inclination to bifurcate.

The pulp chamber and pulp canal is a miniature of the crown and roots; there are usually two pulp canals in the anterior root and one in the posterior, though in many cases there are two. The number of pulp divisions being governed by the number of bifurcations of the roots.

THE THIRD MANDIBULAR MOLAR is usually of the same general character as the first or second molar, though like the third maxillary molar it is subject to great variations, as to the number of cusps, roots, and pulp canals.

The crown has five faces as in the first molar, and usually the same number of cusps. The posterior face differs from that of the first and second molar in being more convex or rounded in order to make a "finishing tooth."

The morsal face is similar to that of the first molar, though it is more liable to vary from the typical.

The neck of the tooth is about the same as the first molar, subject to great variations as to the number of roots and their positions, they may be compressed together, spread apart, or curved abruptly backward.

The roots vary in number, sometimes there is apparently only one root, but a cross-section will show several roots compressed together, each with its separate pulp canal; occasionally two roots are found well separated near the neck, allowing an isthmus of bone to pass between them, with the roots finally uniting farther down (see Figs. 123 and 124). This condition makes the tooth very difficult to extract. Occasionally the crown and roots form the segment of a circle (see Fig. 123).

The roots of the third molar sometimes grow down and backward, passing beyond the mandibular canal (see Fig. 338).

The following interesting observation is given by Dr. Hermann Prinz:

"Certain anatomical malformations of the roots of the lower third molars may, on rare occasions, be the cause of very profuse hemor-

rhage, and other serious damage as a result of their extraction. There are, as far as the author knows, five cases on record in which the developing tooth inclosed in the body of its roots the contents of the mandibular canal—their artery, vein, and nerve (see Figs. 123 and 124). The extraction of a tooth possessing such malformations means tearing of the vessels and the nerve, causing extreme hemorrhage, excruciating pain, and finally permanent insensibility of one-half of the lip. These are the symptoms as recorded from cases which occurred in the practices of Roese, of Munich, in 1898, and of Vorslund-Kjaer, of Copenhagen, in 1908."

Deciduous Teeth.—The twenty deciduous teeth are much smaller than the permanent ones. In infancy they fill the jaws, often overlapping each other, until the last one is in place. As the jaws grow and expand continuously from their first development, the deciduous teeth, by the time the child is five years of age, instead of overlapping are often quite separated from each other, as they do not increase in size after they are once formed.

The twelve anterior deciduous teeth are similar in character to the permanent ones, though very much smaller.

The eight deciduous molars are similar to the permanent molars, though very much smaller, their roots diverge much more in order to give room for the development and growth of the premolar teeth. In examination of *x*-rays (Fig. 120) the relative position of the premolars to the deciduous molars is well illustrated. The roots of the deciduous teeth become resorbed and the permanent teeth advance into their normal positions. The position of the premolar should be remembered when extracting a deciduous molar; the forceps must not be placed too far upon the tooth as there is danger of displacing the premolar. Should the roots of the deciduous tooth break during extraction it will do no harm, as they are quickly resorbed.

Fig. 107 is taken from the skull of a child of about six years, showing all the deciduous teeth in position and the developing permanent teeth, except the third mandibular molar and the second and third maxillary molars, which at this period of life are of very immature development. The outer plates of the alveolar process and the

cancellated tissue have been removed, in order that the positions and relations of the dental organs at this period of life may be more clearly seen.

FIG. 107.—Skull of a child, aged about six years, showing all the deciduous teeth in position and the developing permanent ones.

ERUPTION OF TEETH.

The deciduous teeth usually commence eruption, according to C. S. Tomes, as follows:

Mandibular first incisors, from six to nine months.

Maxilla or upper first incisors, from eight to ten months.

Mandibular second incisors and first molars, from fifteen to twenty-one months.

Canines, from sixteen to twenty months.

Second molars, from twenty to twenty-four months.

By close observation it will be found that the above table is liable to considerable variation.

According to Holt:[1]

At the age of one year a child should have six teeth.

At the age of one and a half years a child should have twelve teeth.

At the age of two years a child should have sixteen teeth.

At two and a half years a child should have twenty teeth.

Various authorities give eruption of the permanent teeth as follows:

The mandibular teeth precede those of the maxilla by short intervals.

First molars, sixth year.

First central incisors, seventh year.

Two second lateral incisors, eighth year.

First premolars, ninth year.

Second premolars, tenth year.

Canines, eleventh to twelfth year.

Second molars, twelfth to thirteenth year.

Third molars, seventeenth to twenty-fifth year.[2]

The deciduous teeth commence to be shed about the age of six, beginning usually with the mandibular first incisors, soon followed by the first maxillary incisors. The permanent first incisors soon taking their places. These teeth will often overlap each other. Then the second incisors are shed and the permanent ones fill their places. In many children's mouths these teeth do not erupt into their typical positions, sometimes from lack of room, but more often because the deciduous teeth are either not shed at the proper time, or they are lost too early, either by decay, accident or injudicious extraction.

The time of shedding the canine teeth is less definite than that of the other deciduous teeth. If they can be held in position until the premolars have erupted there will be a better space reserved for the permanent canines to erupt.

The deciduous first molars are usually shed the eighth year and the second molars at nine years of age. These deciduous molar teeth are not replaced by molar teeth, but by the premolars.

[1] Gray's Anatomy, eighteenth edition, p. 1125.

[2] The foregoing table is from Gray's Anatomy, eighteenth edition, p. 1125.

From about the age of five or six years, before any of the deciduous teeth are shed, there are more fully developed teeth and those in process of growth in the mouth than at any other period of life, at least forty-eight teeth are in various stages of transition. The roots of the deciduous teeth, twenty in number, are becoming resorbed and preparing to be shed, while the roots of many of the permanent teeth are developing, also the roots and crowns of later permanent teeth are growing and changing their positions in the jaws. This great activity goes on from day to day without any pathological disturbance in normally developed, healthy children, but any disturbance which would cut off the nourishment or interfere with the circulation of the jaws proper, as well as of the teeth, might bring about pathological conditions that would not only affect the parts locally but by reflex action, cause systemic troubles such as chronic migraine, indigestion, disturbances of the brain centres inducing corea, epilepsy, neurasthenia, and other diseases of this character. This matter will be further spoken of under Impacted Teeth (see page 166). An abnormal deposit of salts of calcium may occur in the bone, which may prevent the teeth from erupting into their normal positions, or might even cause the cancellated tissue of the alveolar process to become fixed, producing a narrow, dental arch, which, in turn, forces the tongue back into the pharynx, carrying the soft palate upward and plugging the posterior nares, thus interfering with respiration through the nasal passage and blocking the proper drainage of the nasal cavity and its accessory sinuses. One has only to look at Figs. 113 and 114 to see the mass of tooth organs and to realize the mischief which could be produced by injudicious mechanical interference at this time, as well as by pathological disturbances.

VARIOUS ILLUSTRATIONS OF JAWS AND TEETH.

Fig. 108. The anterior portion of the base of a typical skull, showing the bones forming the roof of the mouth, the sutures, and the various foramina. The occluding surfaces of the sixteen maxillary

teeth have an outward inclination, while the mandibular teeth are inclined inward. This allows the outer cusps of the upper teeth to "bite" over the outer cusps of the lower teeth (see Fig. 111). The zygomatic arches extend from the zygoma at the side of the upper jaw

FIG. 108.—Anterior portion of the base of a typical skull.

to the temporal bone, thus giving the support of a flying buttress to the maxillæ. The posterior nares can be seen separated by the vomer, which also assists in supporting the upper jaw.

Fig. 109. Upper portion of the body of a typical mandible, showing the occluding surfaces of the sixteen mandibular teeth, which are

in good alignment; the outer faces of the buccal cusps have an inward inclination which allows the buccal cusps of the maxillary teeth to occlude over them.

Fig. 110[1] gives an anterolateral view of an almost ideal occlusion of the permanent teeth. The illustration shows the relation of the bones forming the external structures of the jaws. The outer surfaces of the lateral and anterior walls of the maxillary sinus are shown, the

FIG. 109.—Upper part of the body of a typical mandible.

teeth having been denuded of the external plate of the alveolar process. It will be seen that in removing the external plate the maxillary sinus has been opened into immediately over the roots of the molars, showing how thin, in this case, is the bone between the roots of the teeth and the external wall of the sinus. It is also very thin over the roots of the canine and first and second premolars.

Figs. 43, 44 and 110 demonstrate the arrangement of the cancel-

[1] Fig. 110 is a duplication of Fig. 31.

lated tissue between the teeth, also between the teeth and the cortical bone, where it acts as an elastic cushion to lessen shock from blows upon the mandible or from concussion in mastication. It is this arrangement which permits the movement of the teeth in various directions during eruption or in correcting irregularities of the teeth.

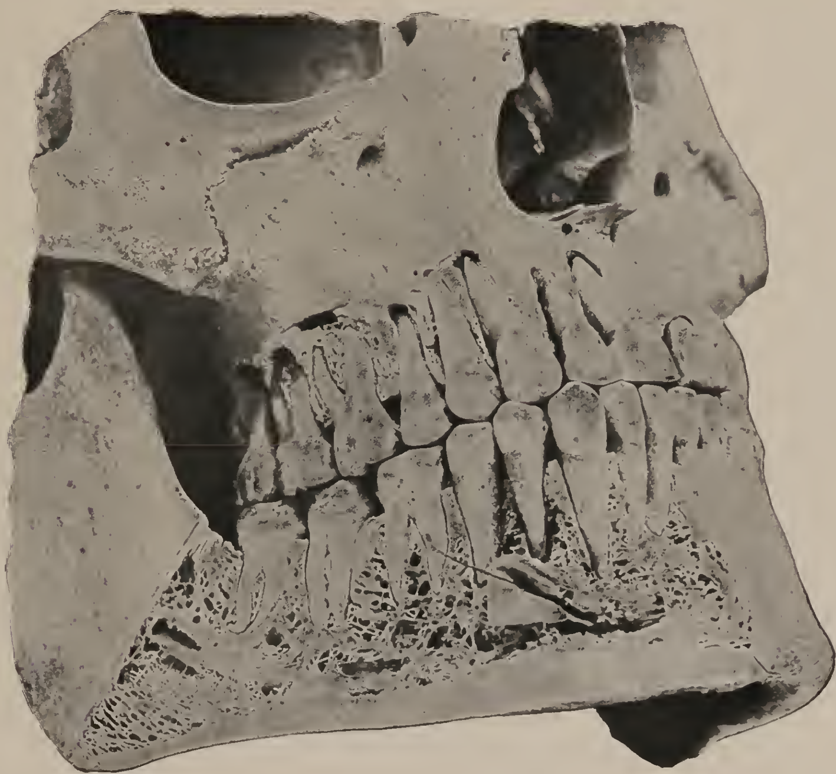


Fig. 110.—Anterolateral view of the maxilla and mandible with the external plates of the alveolar process and some of the cancellated tissue removed, exposing the roots of the teeth, the cribriform tubes, and mandibular canal.

Fig. 111. The right side of the lower portion of the face, showing the relation of the mandible with the base of the skull. It also shows a typical occlusion of the teeth, each tooth occluding with two other teeth, except the third maxillary molar and the first mandibular incisor.

Fig. 112. *X*-ray of the lower portion of the right maxilla and the mandible, showing the internal structures, such as the cancellated tissue, the shapes of the roots, and their relation with surrounding tissue. The mandibular canal, the maxillary sinus and a portion of the mastoid cells are outlined. The occlusion of the teeth is good. A rudimentary maxillary fourth molar is also shown.

Fig. 111.—The right side of the lower portion of face.

Fig. 113, an *x*-ray from a living subject, showing maxillary and mandibular teeth. The first mandibular molar has been diseased, treated, and filled. The anterior root is flattened and not of easy access, consequently the canal has not been properly filled, the posterior root is larger and nearer straight, so treatment is not difficult, shown by the better filled root. The roots of the second mandibular molar are compressed, probably owing to lack of room at the time of formation, the space being small between the first molar and the morsal face of the third impacted molar. The third molar is of the

usual type of impaction always difficult to extract, its morsal face is not only interlocked with the second molar tooth, but its peculiar-shaped roots are imbedded under hard, cortical bone. As soon as such impaction is discovered, one would be justified in extracting the second molar, allowing the third to remain for future development.

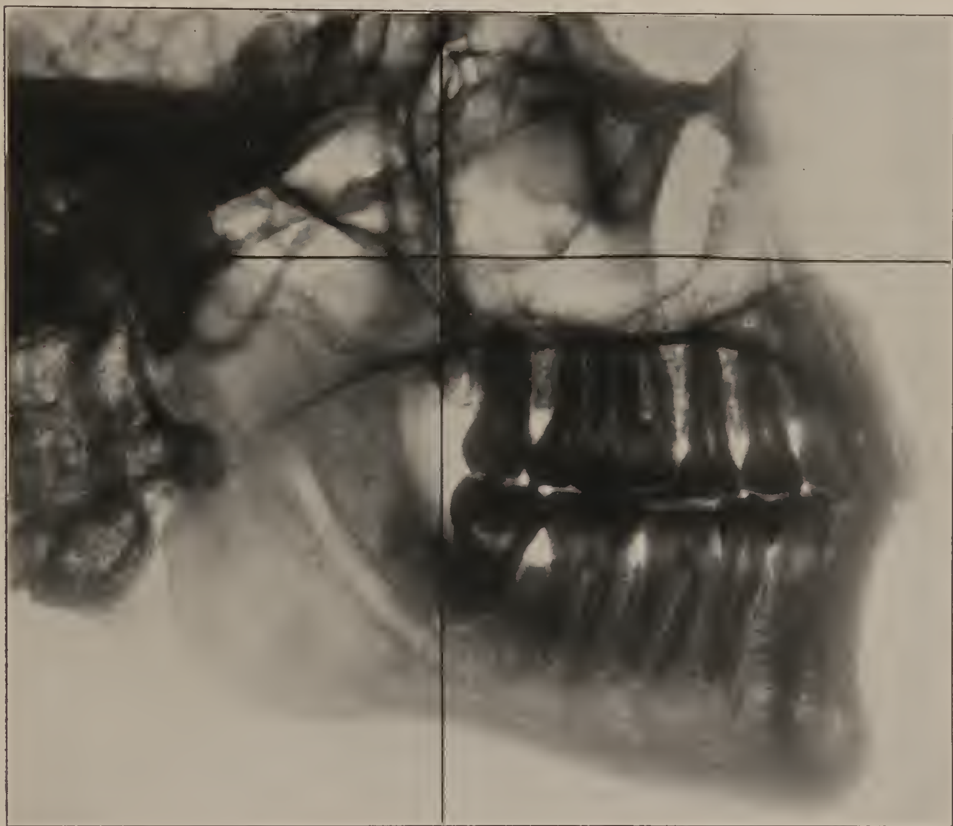


FIG. 112.—*X*-ray of dried skull. (*X*-ray by Dr. Pancoast.)

The first, second and third maxillary molars are all abnormal; their roots are compressed; the third molar is impacted against the posterior portion of the second molar. In this case also the second molar should be extracted first as there would be great liability of damaging the tissue surrounding the third molar. A portion of the

root is above the floor of the maxillary sinus. The second molar with its compressed roots often gives serious trouble through the pulp becoming diseased.

FIG. 113.—*X*-ray of living subject. (*X*-ray by Dr. Pancoast.)

Fig. 114. Horizontal section made at the necks of fourteen mandibular teeth, showing the shape of the teeth in cross-section at this

point, also the shape and size of the pulp chambers in a matured skull. In a younger skull the pulp chamber would be relatively larger.

FIG. 114.—Horizontal section made at the necks of fourteen mandibular teeth.

FIG. 115.—Horizontal section made at the necks of sixteen mandibular teeth.

Fig. 115. Horizontal section made at the necks of sixteen mandibular teeth, showing the shape and relation of the teeth at this point.

It also shows the investing membranes of the teeth and the lining of the sockets. The periodontal membrane has various functions, it acts as a cushion between the tooth and the bone, and assists in hold-

Fig. 116.—Anteroposterior section through the maxillary sinus, alveolar process and the teeth.

Fig. 117.—*X*-ray picture of the left half of the lower portion of an upper jaw. (*X*-ray by Dr. Pancoast.)

ing the tooth in the alveolus, giving room for the passage of nutrient vessels and nerves.

Fig. 116. Anteroposterior section through the maxillary sinus, alveolar process and the teeth, showing the relation of the teeth to each

FIG. 118.—*X*-ray picture of the right half of the lower portion of an upper jaw. (*X*-ray by Dr. Pancoast.)

FIG. 119.—*X*-ray of the right half of the body of the mandible. (*X*-ray by Dr. Pancoast.)

other and to the maxillary sinus, which, in this particular skull, are normal though not typical. The shapes of the pulp cavities are also indicated.

Figs. 117 and 118. Two *x*-ray pictures of the right and left halves of the lower portion of an upper jaw. This skull is nearer typical

Fig. 120

Fig. 121

Figs. 120 and 121.—*X*-ray pictures of the left half of the maxilla and mandible of a child, about five years of age, showing ten deciduous and twelve permanent teeth; the latter are in the process of formation. (*X*-rays by Dr. Pancoast.)

than that in Fig. 116. The lower outlines of the maxillary sinuses are shown, also the alveolar processes, the pulp cavities, and their canals. The apparent relations of the roots of the teeth to the maxillary sinuses

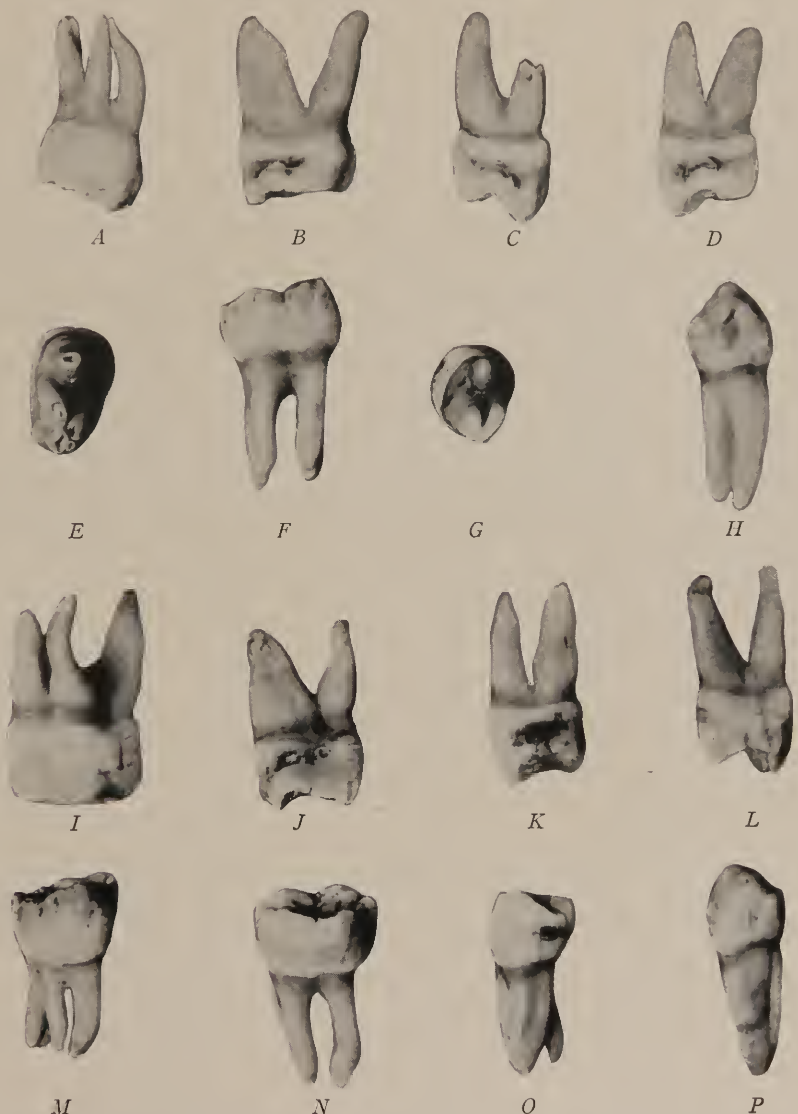


FIG. 122.—Sixteen teeth taken from one skull; nearly all of the roots have some peculiarity. (Through courtesy of Dr. Ottolengui.)

FIG. 123.—A collection of twenty abnormal teeth; among them are fusions, odontomes, and irregularities, etc.

are deceptive to one not familiar with x-ray pictures. The lower outlines of the sinuses are below the points of the roots of the teeth, which

FIG. 124.—A group of nineteen abnormal teeth.

might indicate that the ends of the roots had penetrated the sinus, instead of this they are in the walls of the sinus (see Fig. 97). The

white lines running downward and forward from the posterior wall of the sinuses are the grooves or canals for the passage of the maxillary nerves and vessels; branches may be seen going to roots of the various teeth.

Fig. 119. *X*-ray of the right half of the body of the mandible, showing the cancellated tissue of the bone, a typical view of the teeth, and outlines of the pulp chambers and canals.

Figs. 120 and 121. *X*-ray picture of the left half of the maxilla and mandible of a child, about five years of age, showing ten deciduous and twelve permanent teeth; the latter are in the process of formation.

Fig. 122. Sixteen teeth taken from one skull. It will be noticed that nearly all of the roots have some peculiarity. *A*, right mandibular third molar, four roots; the anterior and posterior are flattened with two apical foramen in each root. A buccal root is well shown, and there is also a small lingual root not shown, making six apical foramina; *C* and *D*, right first and second maxillary premolars, two roots each; *E*, left maxillary third molar, five roots; *F*, left mandibular second molar, the anterior and posterior roots both bifurcated; *G*, left mandibular second premolar, three roots; *H*, left mandibular first premolar, two roots; *K*, right maxillary second premolar, three roots; *L*, left maxillary first premolar, two roots; *M*, left mandibular third molar, three roots; *O*, left mandibular second premolar, three roots; *P*, right mandibular first premolar, three roots compressed together.

THE VASCULAR SUPPLY OF THE TEETH.

The teeth receive their supply from the internal maxillary artery, which also supplies all the deep portions of the face, including part of the floor of the mouth, the palate, the nasal cavities, the maxillary sinus, the greater portion of the ethmoid cells, part of the pharynx, and part of the dura mater of the brain.

The supply to the maxillary teeth comes from the internal maxillary, through the alveolar artery. It passes through the foramen, just along the tuberosity of the maxilla into the sinus, passing forward

on the outer wall of the sinus and entering the anterior wall where it anastomoses freely with the infraorbital and other arteries. During its course it gives off branches to the roots of the maxillary teeth, their investing membrane, the alveolar process, and the mucous membrane of the maxillary sinus. In a general way it accompanies the superior alveolar nerve.

The first or maxillary division of the internal maxillary artery extends from the external carotid to the sphenomandibular ligament, and gives off five branches, which pass into or through osseous foramina. These branches are the deep auricular, anterior tympanic, middle and small meningeal, and the inferior alveolar.

The second or pterygoid division extends from the sphenomandibular ligament to the point at which the artery passes through the space between the two heads of the pterygoideus externus (external pterygoid muscle). This portion has six branches which supply the masticatory and buccinator muscle. They are named, according to their distribution, the two deep temporal, two pterygoid, the masseteric, and the buccinator.

The third or pterygopalatine division extends from the inner surface of the internal pterygoid muscle to the termination of the artery in the pterygopalatine fossa. It gives off six branches, each passing into or through the osseous foramina. They are likewise named according to the parts supplied by them, the alveolar already described, infraorbital, descending palatine, artery of the pterygoid canal, pharyngeal, and sphenopalatine.

The inferior alveolar artery arises from the under part of the internal maxillary. It passes downward and forward between the sphenomandibular ligament and the neck of the mandible to the mandibular foramen, through which it passes into the canal, accompanied by the alveolar nerve, it then terminates anterior to the mental foramen, where it separates into two divisions, known as the incisor and mental branches.

The mylohyoid branch is given off from the inferior alveolar artery immediately before entering the foramen. It descends into the mylohyoid groove with the nerve and vessels of the same name, and is

distributed to the under surface of the mylohyoid muscle. The portion of the alveolar artery within the canal gives off numerous small branches to supply the teeth and their surroundings. The incisor branch is a continuation and passes forward within the cancellated structure of the bone to supply the region of the chin and the anterior teeth.

The mental branch passes through the mental foramen, accompanied by the nerve of the same name, and supplies the soft parts in the region of the chin.

In this manner the mandible is richly supplied with blood.

As the inferior alveolar artery enters the bone at the mandibular foramen, it passes downward and forward through the body of the bone to the symphysis, and anastomoses with the artery from the opposite side. At a point near the incisor teeth a great portion of the artery curves upon itself and passes out through the mental foramen, anastomosing with the submental, inferior and superior labial or coronary branches of the external maxillary or facial artery. In this manner two complete collateral circulations are formed on the two sides. The mandible is also well supplied through the periosteum of the body of true bone and the mucoperiosteum of the alveolar process. The vessels from these sources pass into the bone and have free anastomotic relations with the internal supply of blood.

Fig. 125 is from an *x*-ray picture of the left half of a mandible of a mature dog, which was injected through the inferior alveolar artery. The illustration shows that the mercury passed through the artery to all portions of the bone, the alveolar process, and the teeth, and demonstrates the complete anastomotic relations which the arteries have to each other. A stereoscopic picture would show that branches are given off from the artery as it passes along its canal or tube, to the roots of the teeth and the intervening tissue. It proves that any portion of the artery can be removed without destroying the vitality of any tissue of the jaw, provided that the artery be not destroyed between the structures and the nearest branch of the collateral circulation, and also shows that in order to destroy the vitality of a tooth pulp the blood supply would have to be cut off immediately at the apical foramen.

It does not follow that a tooth that does not "respond" to thermal changes, or even to the electric current, is necessarily a devitalized tooth. In operations for neuralgia the surgeon often removes a great portion of the mandibular vessels and nerve, or he may remove the semilunar ganglion, but in so doing he does not destroy the vitality of the tissue supplied. He destroys the function of communication with the sensorium. When the trigeminal nerve is crippled by resection or by the removal of the semilunar ganglion, the wise surgeon protects

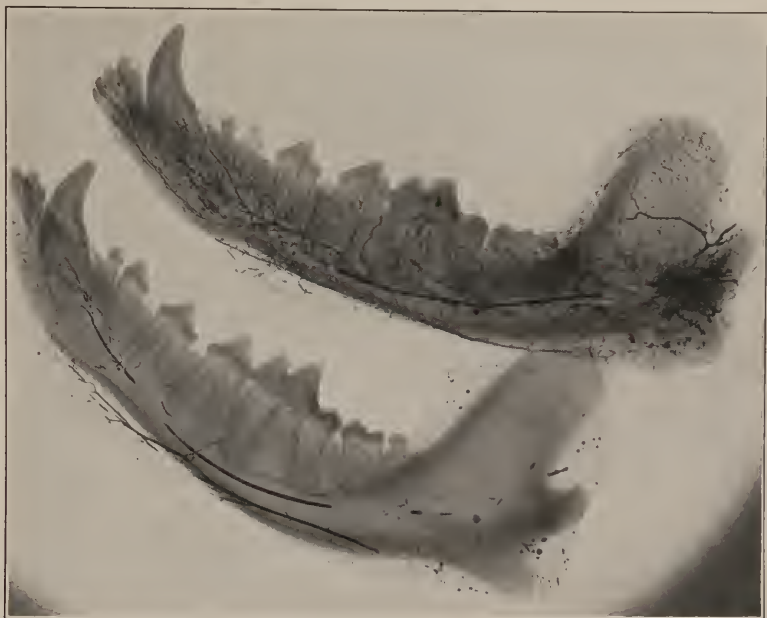


FIG. 125.—From an *x*-ray picture of the mandible of a dog. The arteries had been injected with mercury. (*X*-ray by Dr. Pancoast.)

the parts from injury. A tooth under similar conditions should also be protected and not subjected to "test." In time it will regain its sensation, provided meddlesome surgery has not destroyed the pulp.

In the application of a spray of ethyl chlorid to the gums to produce an anesthetic condition for lancing an abscess, great care should be taken to protect any vital tooth, for there may be danger of producing its devitalization by the sudden and extreme lowering of its temperature.

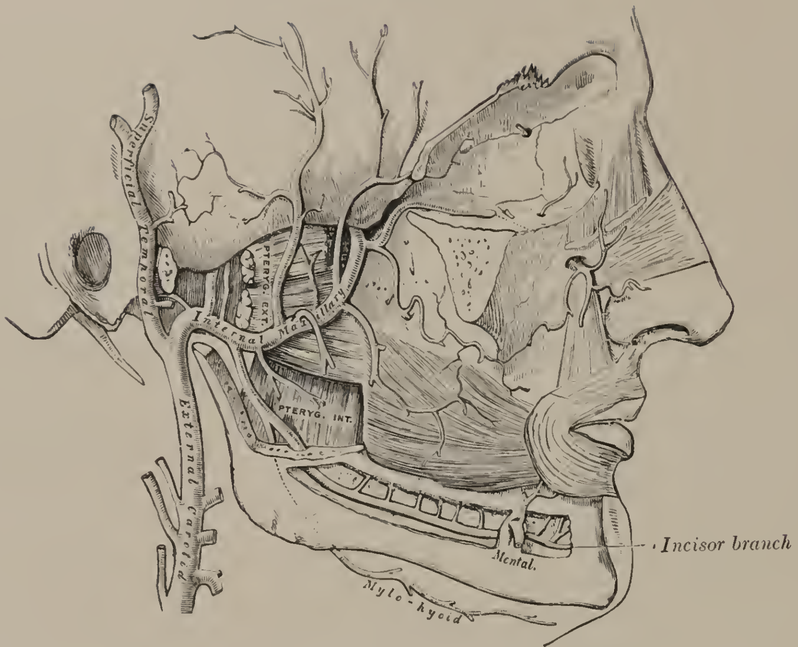


FIG. 126.—The internal maxillary artery. (Gray.)

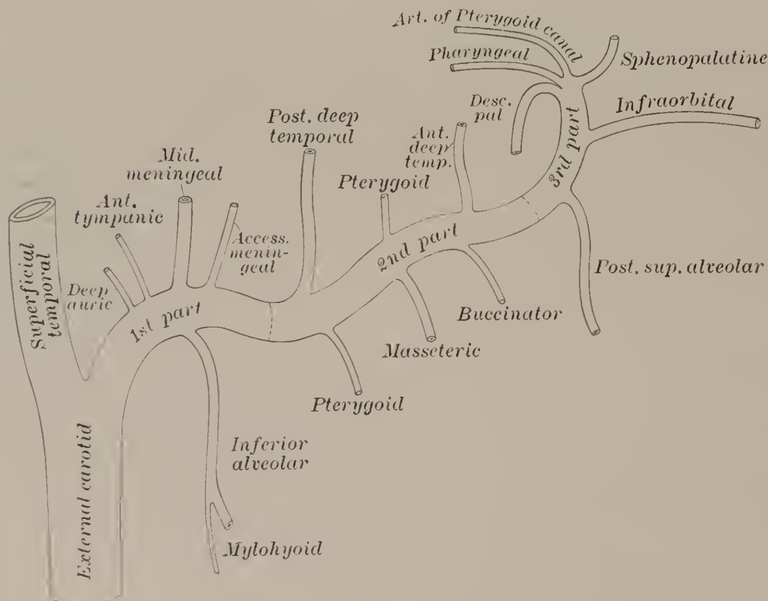


FIG. 127.—Plan of branches of internal maxillary artery. (Gray.)

THE SENSORY NERVE SUPPLY OF THE TEETH AND FACE.

The Trigeminal Nerve.—The sensory nerve supply of the teeth and associated parts is governed by the trigeminal (trifacial or fifth nerve), which is the largest of all the cranial nerves. Through its wide distribution within the face and head, its close relation to other nerves and to the plexuses and ganglia of the sympathetic system (Fig. 128), it becomes involved in nearly all the diseases of the external portion of the head as well as the superficial and deep parts of the face. "The intimate relations which the nerve bears with the points of origin of the sixth, seventh, eighth, ninth, tenth, eleventh, and twelfth cranial nerves in the floor of the fourth ventricle possibly explain many of those phenomena which are considered as reflex in character, and whose starting-point seems to depend upon some irritation of the fifth nerve by means of various branches" (Ranney). It resembles a spinal nerve, in that it arises by two roots, anterior and posterior. The posterior root is sensory in character, and has a ganglion upon it, while the anterior root has no ganglion and is motor in character.

The large, sensory, or posterior root emerges from a point in close proximity to the centre of the lateral surface of the pons Varolii, but nearer its superior than its inferior border.

The small, motor, or anterior root is made up of six or eight rounded filaments (Vulpian), and emerges from the pons a little above the larger posterior root, being separated from it by a few transverse fibers of white substance. It is entirely distinct and separate from the larger sensory root until it passes out of the cranial cavity through the foramen ovale, when it becomes closely united with the third or mandibular division.

The deep origin of these two roots is widely separated from their superficial origin. Following them backward from the anterior surface of the pons Varolii, they pass directly through the pons to the medulla oblongata, without any connection whatever with its fibers. On reaching the medulla they form three main divisions, one anterior and two posterior.

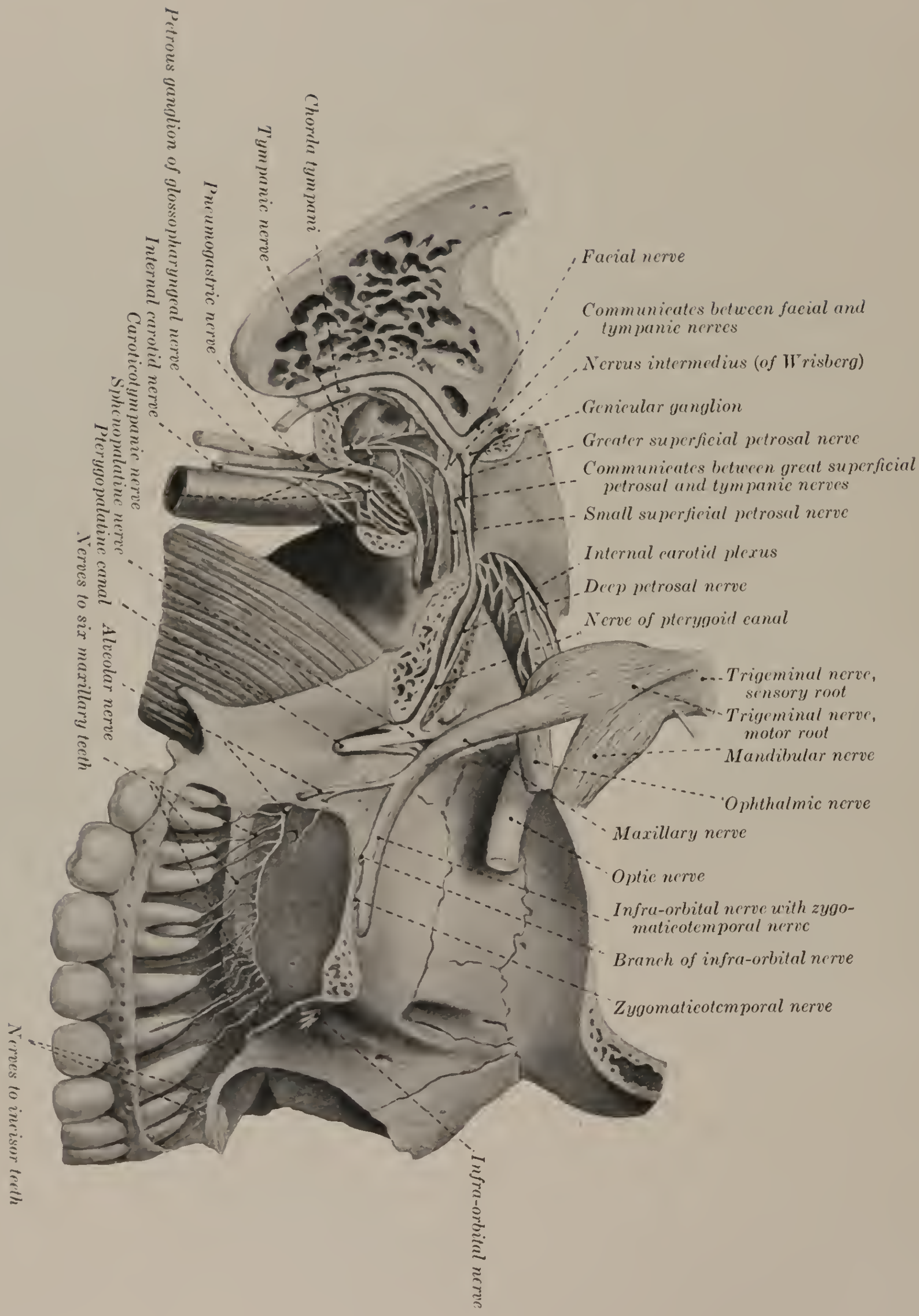


Fig. 128.—Distribution of the maxillary alveolar nerve. (Modified from Sobotta.)

The anterior or motor division arises from the motor nucleus of the trigeminal nerve, which is composed of large, ramified, and pigmented cells situated below the lateral angle of the fourth ventricle, anterior to the inferior facial nucleus, and on the proximal side of the large sensory nucleus of this nerve. It also arises from the gray matter at the anterior portion of the *iter* beneath the corpora quadrigemina.

The two posterior or sensory divisions give general sensibility to the face and head, extending as far back as its vertex.

From their superficial origin these two divisions extend obliquely upward and forward across the summit of the petrous portion of the temporal bone, and pass through an oval opening in the dura mater into the middle fossa of the brain-case. The larger posterior sensory root terminates in the semilunar, which is situated in a depression on the superior part of the anterior surface near the apex of the petrous portion of the temporal bone. This ganglion is broad, flattened, and somewhat crescent-shaped. Its convexity is directed forward and slightly upward. The cells of this ganglion are unipolar in shape. Its surfaces are striated, and it receives on its inner side filaments of communication from the carotid plexus of the sympathetic nervous system.

From the anterior or concave margin of the ganglion the three large divisions of the trigeminal nerve commence. It is from this that the nerve receives its name.

The ophthalmic, or first division of the trigeminal nerve, is the smallest of the three cords, being but about an inch in length. Its fnuction is to impart sensation to the eyeball, the lacrimal gland, the mucous lining of the eye, and a portion of the nose, the eyebrow and forehead. It commences from the upper, inner, and anterior portion of the margin of the semilunar ganglion. It is a flattened cord, and passes forward along the outer wall of the cavernous sinus, and terminates before or just as it is about to pass through the supraorbital fissure by dividing into three main branches, the frontal, lacrimal, and nasal, which are distributed as their names indicate.

Branches of the Ophthalmic Nerve.—

Those within the cavernous sinus,	Lacrimal,
Frontal,	Nasociliary.

The frontal nerve is the largest of the branches given off by the ophthalmic, and is in reality its axial continuation. It enters the orbit through the most superior portion of the supraorbital fissure, and passes forward in the median line above the muscles and below the periosteum. It terminates midway between the apex and base of the orbital cavity, above the levator palpebræ superioris, by dividing into two branches of unequal size, the supratrochlear and the supraorbital.

The supratrochlear nerve is much the smaller of the two terminal branches of the frontal. It extends obliquely inward and forward over the trochlear muscle, passing out of the orbit, and curving around the supraorbital arch between the supraorbital foramen and the trochlear fossa. It then extends beneath the corrugator and frontalis muscles, and divides into two terminal branches. These branches pierce the orbicularis and frontalis muscles, supplying them as well as the integument; also the lower and median portion of the forehead, interlacing with the corresponding nerve of the opposite side. This nerve also gives off two distributing branches, one extending from the nerve near the trochlear muscle, which passes downward and joins the infratrochlear branch of the nasociliary nerve, and the other near its exit from the orbit, which passes to the eyelid and bridge of the nose.

The supraorbital nerve is really a continuation of the frontal. It passes forward, and emerges from the orbit through the supraorbital notch or foramen. It then curves upward on the forehead, and divides into a median and a lateral branch, which pierce the muscles and become the cutaneous nerves. Its branches of distribution are several small cords which descend to the structures of the upper eyelid, and one which passes outward under the orbicularis oculi, interlacing with the facial nerve. The muscular branches are distributed to the corrugator, frontalis, and orbicularis oculi. The cutaneous branches are two in number, median and lateral. These extend posteriorly as far as the occiput. The deep or pericranial branches are distributed to the frontal and parietal bones. This nerve also sends a filament which supplies the mucous membrane of the frontal sinus. Occasionally the division of the supraorbital nerve takes place within the orbit, the larger branch passing through the supraorbital foramen,

while the smaller branch extends internally around the supraorbital arch or through the frontal notch, which is occasionally present.

The lacrimal nerve is the smallest of the three branches of the ophthalmic. It passes along the outer side of the frontal nerve into the orbit through the anterior foramen lacerum, encased in an individual sheath derived from the dura mater. It passes forward and outward near the periosteum of the orbit above the Rectus lateralis to the lacrimal fossa of the frontal bone, accompanied by the lacrimal artery. It then penetrates the external tendo oculi and terminates in the upper eyelid.

Branches of Distribution.—On approaching the lacrimal fossa the lacrimal nerve sends a communicating cord to the zygomaticotemporal branch of the maxillary nerve. This branch occasionally passes backward through a canal in the outer wall of the orbit, its divisions forming an arch from which branches are distributed to the lacrimal gland and the conjunctiva. Within the lacrimal fossa it sends branches to the lacrimal gland and the conjunctiva.

THE NASOCILIARY NERVE is intermediate in size between the other two branches of the ophthalmic nerve. It commences from the under surface of the ophthalmic nerve, and passes through the widest portion of the foramen lacerum into the orbit between the two heads of the Rectus lateralis, accompanied by the fourth nerve. On either side of it are the two branches of the third nerve. From the foramen it passes obliquely inward and forward over the optic nerve below the Rectus superior and Obliquus superior to the anterior ethmoidal foramen on the inner wall of the orbital cavity. It here divides into the internal nasal and infratrochlear nerves.

Branches of the Nasociliary Nerve.—

Branch to the dura mater,	Long ciliary,
Communicating branches to sympathetic nerve,	Sphenoethmoidal,
	Internal nasal,
Ganglionic,	Infratrochlear.

The branch to the dura mater is a small filament which turns backward and is distributed to the dura mater of the anterior cerebral fossa.

The communicating branches to the sympathetic are a few distinct filaments which communicate with the sympathetic network about the ophthalmic artery (Allen).

The ganglionic branch is quite slender and about half an inch in length. It usually commences from the nasociliary as it extends between the two heads. It passes along the outer side of the optic nerve, and terminates at the posterior portion of the ciliary ganglion, constituting its long or sensory root.

The long ciliary nerves are two or three in number, and commence from the nasociliary as it extends across the optic nerve. They pass along the inner margin of this nerve, and unite with some of the short ciliary nerves from the ciliary ganglion. They then pierce the sclera of the eye, pass forward between it and the choroid, and are distributed to the ciliary muscles, the cornea, and the iris.

The spheno-ethmoidal (Luschka) *or posterior ethmoidal* (Krause) *nerve* passes from the nasociliary to the posterior ethmoidal foramen (posterior internal orbital canal), and is distributed to the mucous membrane of the sphenoidal sinus and the posterior ethmoidal cells in front of the body of the sphenoid bone.

The internal nasal or ethmoidal nerve is in the line of continuation of, and generally described as, the nasociliary nerve. It passes through the anterior ethmoidal foramen, situated between the frontal and ethmoidal bones, into the brain-case, just external to the cribriform plate. It then extends in a shallow groove along the outer wall of the plate to the cerebronasal slit near the crista galli, passes through this slit, enters the nasal cavity, and divides into three branches—the internal or septal branch, the lateral, and the anterior superficial branch.

The internal or septal branch of the internal nasal nerve passes downward and forward, and supplies the anterior portion of the septum of the nose.

The lateral branches of the internal nerve usually comprise two or three filaments which are distributed to the anterior portions of the lateral walls of the nasal cavity, including the extremities of the middle and inferior concha bones.

The anterior or superficial branch passes downward in a longitudinal groove or canal on the internal surface of the nasal bone until it reaches the lateral cartilage of the nose. Here it extends between the bone and the cartilage, runs beneath the nasalis, and becomes superficial, terminating in the spine, the wing, and the tip of the nose.

The infratrochlear nerve is one of the terminal branches of the nasociliary, it being given off near the anterior ethmoidal foramen. It passes forward along the inferior border of the obliquus superior, and parallel to the supratrochlear nerve, and receives a communicating branch from it. As it approaches the trochlea it passes to the inner angle of the eye and divides into two sets of branches. Those of the superior set are distributed to the superficial structures of the superior eyelid; while those of the inferior set are distributed to the superficial structures at the root and side of the nose, the superficial portion of the inferior eyelid, the caruncle, conjunctiva, the lacrimal sac, and the lacrimal duct.

Variations.—"The nasociliary nerve occasionally (frequently, Krause) gives filaments to the superior and internal recti. A branch to the levator palpebræ superioris has been met with (Fäsebeck); offshoots from the nerve as it traverses the anterior internal orbital canal to the frontal sinus and ethmoidal cells are described by Meckel and Langenbeck."

Maxillary Nerve.—The maxillary or second division of the trigeminal nerve is the second in size of its three great divisions. It is composed entirely of sensory fibers, and gives sensation to nearly all the structures of and around the superior maxillary bone. It commences in the centre of the convex or anterior margin of the semilunar ganglion by a flattened and plexiform band, passes horizontally and directly forward, and leaves the cranium through the foramen rotundum in the great wing of the sphenoid bone. It then enters the pterygopalatine fossa, and becomes more rounded and firmer in texture. It passes across this fossa surrounded by adipose tissue, and enters the infraorbital groove, and receives the name of infraorbital nerve. It then passes through this canal, and emerges upon the face through the infraorbital foramen. The branches of this nerve can be divided into four groups, according to the locality of their origin.

The Zygomatic branch is a small nerve which arises from the upper portion of the maxillary nerve just after it emerges from the foramen rotundum. It passes forward into the orbital cavity through the pterygopalatine fissure, and immediately divides into two branches, temporal and zygomatic.

The zygomaticotemporal branch passes forward in a groove on the outer wall of the orbit until it reaches the temporal canal in the zygomatic bone. It passes through this canal into the anterior portion of the temporal fossa, ascends between the bone and the temporal muscle a short distance, pierces the muscle and its aponeurosis about an inch above the zygoma, and terminates in filaments which supply the cutaneous structures of the temporal region and the side of the forehead. It interlaces with the facial and occasionally with the third division of the fifth nerve. That portion of the nerve within the orbit sends one or two filaments of communication to the lacrimal nerve, a branch of the ophthalmic division of the trigeminal.

The zygomaticofacial (malar) branch at its commencement passes through the loose adipose tissue at the lower angle of the orbit to the zygomatic bone, through which it extends and emerges upon the face usually by two branches. It is distributed to the cutaneous tissues in the region of the cheek, and interlaces with the facial nerve.

The sphenopalatine branches are usually two in number, and are given off from the middle of the lower surface of the pterygomaxillary portion of the second division of the trigeminal nerve. They pass downward to the sphenopalatine or Meckel's ganglion.

The Superior Alveolar Nerve.—The superior alveolar nerve branches from the maxillary in the pterygopalatal fossa before it enters the infraorbital groove, and just after two branches go to the sphenopalatal ganglion. The nerve passes downward along the zygomatic surface of the maxilla. A little above the tuberosity its branches enter one or more foramina and pass into the maxillary sinus, part of the nerves supplying the walls and mucous membrane. The main portion enters a groove in the outer wall and passes into a canal as it enters the anterior wall of the sinus. The superior alveolar nerve gives off branches to the three maxillary molars, two premolars

and canine, and with its branches supplies not only the maxillary teeth but also the alveolar process, the gum tissue, the investing membrane of the roots of the teeth and sockets, the mucous membrane and bone of the floor of the sinus. The incisor teeth are more than likely supplied by the arteries and nerves belonging to the original incisive bud. The arteries anastomose with one another no matter what their origin be, but the nerves do not, though they interlace with each other.

The Infraorbital Nerve.—After the maxillary nerve enters the infraorbital groove it passes along the floor of the orbit, and through the infraorbital canal terminating at the infraorbital foramen, where it divides into three sets of branches.

The inferior palpebral branch is generally made up of two nerves. They ascend in a groove or canal, pass through the upper portion of the elevator muscle of the upper lip, and are distributed to the orbicularis oculi, the skin, the conjunctiva of the lower eyelid, and interlace at the outer angle of the orbit with the zygomaticofacial and facial nerves. A branch also passes inward and interlaces with the external nasal nerve, a division of the ophthalmic.

The nasal or internal branches, two or three in number, are distributed to the skin of the nose and the lining membrane of the nostril, and interlace with the nasociliary nerve.

The superior labial or descending branches are more numerous than the branches of the other sets from the infraorbital nerve. They pass downward beneath the Quadratus labii superioris muscle, and are distributed to the upper lip, its skin, mucous (labial) glands, and mucous membrane. They also extend to the anterior portion of the gums.

The infraorbital plexus of nerves is situated below the orbit, and is composed of branches from the infraorbital and facial nerves.

The Mandibular Nerve.—The mandibular nerve is the largest of the three divisions of the trigeminal nerve. It differs from the other two in the fact that its function is mixed, being both sensory and motor; it also probably supplies in a measure the special sense of taste. This nerve is distributed to the lower portion of the face, the mandible, and mandibular teeth, a portion of the tongue, and the muscles of mastication.

The sensory (or larger) *portion* arises from the inferior lateral and anterior part of the margin of the semilunar ganglion. It passes downward through the foramen ovale in the sphenoid bone, accompanied by the smaller anterior or motor root. Immediately after its exit from this foramen the two portions unite, their fibers interlacing, to form one nerve, the mixed function of the nerve being thus accounted for. It then descends vertically to the pterygoideus externus, and divides into two sets of branches, anterior and posterior.

The anterior motor branch or trunk of the maxillary nerve is the smaller of the two, and is composed almost entirely of motor filaments, which are distributed to the muscles of mastication. It is divided into four branches:

Deep temporal,	External pterygoid,
Masseteric,	Buccinator.

The deep temporal branches are usually two in number, though occasionally there are three—anterior, middle, and posterior.

The anterior branch before piercing the pterygoideus externus is joined by a communicating filament from the buccal nerve. It ascends across the pterygoid ridge of the sphenoid bone, passes to the anterior portion of the temporal fossa, and supplies that part of the temporalis situated in this region.

The deep temporal branch passes outward above the pterygoideus externus, then curves upward, running close to the temporal bone, and is distributed to the deep and internal portions of the temporalis.

The posterior temporal branch is made up entirely of motor filaments. During the first portion of its course it is often associated with the masseteric nerve. It passes in a tortuous manner upward and outward, then upward through the proximal surface of the temporalis; it passes out of this muscle and through its fascia from a half to three-quarters of an inch above the zygoma, and then turns upward beneath the skin and interlaces with the auriculotemporal and facial nerves.

The masseteric nerve is larger than the deep temporal, and arises in close proximity to it. Occasionally these two nerves arise as a common

trunk from the third division of the fifth nerve. It passes backward and outward between the upper portion of the zygomatic fossa and the superior border of the pterygoideus externus, curves slightly downward and outward, and passes through the mandibular notch in the mandibular bone. It then extends downward between the ramus of the bone and the masseter muscle, to which muscle it is mainly distributed. Its other branches of distribution are, first, a small communicating filament which interlaces with the deep temporal, and an articulating branch which passes to the mandibular articulation.

The internal pterygoid nerve is the shortest branch of the third division of the trigeminal nerve. It is given off from its anterior and proximal side on a level with the otic ganglion. It passes backward between the ganglion and the lingual nerve, occasionally extending through the ganglion to the inner side of the pterygoideus internus, to which it is mainly distributed. Its other branches of communication are, first, a motor root to the otic ganglion; second, a filament to the tensor palati; third, a branch to the tensor tympani.

The external pterygoid nerve is not constant in its origin; it seldom arises from the main trunk of the inferior maxillary, but generally in conjunction with the buccal branch or from the internal pterygoid nerve. It is distributed to the pterygoideus externus muscle.

The buccinator nerve, though described under the head of the motor branches of the mandibular nerve, is almost entirely composed of sensory fibers. It arises from the lateral margin of the main trunk of the mandibular nerve by from one to three bundles, and is usually joined at its origin by the anterior deep temporal and the external pterygoid nerves. It passes outward, either between the two heads of the pterygoideus externus or between the two pterygoid muscles; extends downward to the inner surface of the coronoid process of the mandible, thence forward between this process and the tuberosity of the maxilla, occasionally passing between the fibers of the temporal muscle close to its insertion. Midway between the lobe of the ear and the angle of the mouth it becomes superficial, and terminates by dividing into superior and inferior branches.

Branches of distribution are—

(*a*) *Two or three external pterygoids*, which are given off as the nerve passes through the pterygoideus externus.

(*b*) An *anterior deep temporal branch*, which usually joins the deep temporal nerve. It passes upward to the thick portion of the temporalis.

(*c*) A *descending branch*, which passes to the insertion of the temporalis.

(*d*) *Superior terminal branches*, which supply the upper portion of the buccinator muscle, the skin of the zygomatic and buccal region. These branches interlace with the facial nerve near the parotid duct.

(*e*) *Inferior terminal branches*, which pass forward to the angle of the mouth, and are distributed to the skin, the lower portion of the buccinator muscle and the buccal mucous membrane and glands. These branches, together with buccal branches of the facial nerve, form a plexus around the facial vein.

The posterior or sensory branches of the third division of the fifth nerve are—

Auriculotemporal, Mandibular.
Lingual,

The auriculotemporal nerve usually arises by two roots, of unequal size, situated close to the foramen ovale. At first they pass backward and outward, one on either side of the middle meningeal artery. They then unite and form a flattened trunk, which passes back beneath the pterygoideus externus to the inner side of the neck of the condyle. It curves around the condyle in company with the superficial temporal artery, passes upward between the ear and the mandibular articulation, thence over the zygoma and beneath the superficial temporal artery, terminating in several filaments which are distributed to the skin over the greater portion of the temporal region, extending to its superior extremity. They interlace anteriorly with the facial nerve.

Branches of the auriculotemporal nerve are—

Communicating, Parotid,
Articular, Anterior auricular.
Branches to external acoustic meatus,

The communicating branches are slender filaments which pass between the otic ganglion and the third division of the fifth nerve near its origin. One or two branches which are given off near the neck of the condyle of the lower jaw pass forward beneath the facial nerve, unite with it near the posterior border of the masseter muscle, and form one of the principal communicating branches between the facial and trifacial nerves.

The articular branches are one or two fine filaments which pass to the mandibular articulation.

The branches to the external acoustic meatus are two in number, superior and inferior. They pass between the bone and the cartilage to enter the meatus, and are distributed to the lining of the ear. The superior branch gives off a filament to the tympanic membrane.

The parotid branches supply the parotid gland. They are frequently connected with the facial nerve.

The anterior auricular branches are usually two in number. They pass between the tragus and helix, and are distributed to the concave surface of the auricle.

The Lingual Nerve.—The lingual nerve is second in size, and is an important branch of the third division of the trigeminal. From its origin it passes down on the internal surface of the pterygoideus externus, anterior and a little to the inner side of the mandibular nerve. These two nerves have been observed arising from a common trunk and bifurcating near the mandibular foramen. As the lingual nerve reaches the lower border of the muscle it curves forward between the pterygoideus internus and the ramus of the lower jaw, and inclines inward over the superior constrictor of the pharynx, under the styloglossus muscle and above the deep portion of the submaxillary mucosalivary gland. It then extends forward, crosses the submaxillary duct, passes below the mucous membrane of the alveolar lingual groove, and terminates at the apex of the tongue.

Branches of Communication.—Near the origin of the lingual nerve a communicating branch passes over the internal maxillary artery to the mandibular nerve. There is also a small branch which passes to the hypoglossal nerve. This nerve also forms a plexus, from which

branches are distributed to the walls of the internal jugular vein, a portion of the sinuses and the cancelli of the occipital bone, and interlace with branches which pass through the anterior condyloid foramen. The chorda tympani branch, which is a small nerve, arises from the facial, and descends from the proximal extremity of the petrotympanic suture to the acute angle of the lingual nerve as it passes forward close to the lower border of the pterygoideus externus. At first there is only mechanical union between these two nerves, but subsequently they are intimately associated. Branches pass directly to the submaxillary ganglion where it is in close relation with the submaxillary mucosalivary gland. Anterior to the last branch, one or two communicating filaments descend over the first portion of the hypoglossal muscle to interlace with filaments from the hypoglossal nerve.

The branches of distribution of the lingual nerve are—

A small branch to the palatoglossal fold (anterior palatine arch) and the tonsils.

A sublingual branch, which is distributed to the mucous membrane of the floor of the mouth, the gum tissue on the inner surface of the mandible, and the sublingual mucous gland.

The lingual or terminal branches, which pass upward between the fibers of the tongue, divide into finer filaments, which are distributed to the mucous membrane of the anterior two-thirds of the tongue and terminate in the conical and fungiform papillæ.

A *few flexiform* filaments, which pass beneath the tongue, some terminating on the under surface of the tip and in the glands of Nühn.

The Inferior Alveolar Nerve.—*The inferior alveolar nerve* is the largest of the branches of the third or mandibular division of the trigeminal nerve (Fig. 130). From its origin it passes downward, accompanied by the inferior alveolar artery, on the external surface of the pterygoideus externus, posterior and a little to the side of the lingual nerve. After reaching the lower border of the muscle, it passes between the sphenomandibular ligament and the ramus of the mandible, and enters the mandibular canal or tube (see page 11) from which there are small lateral tubes which serve as nerve and vessel conduits to the roots of all the mandibular teeth and surrounding tissue. In the region of the

canine tooth the nerve divides into incisor and mental branches, the former going to the incisor teeth. The latter turns back upon itself, passes along the mental canal and out by the mental foramen.

The branches of the inferior alveolar nerve are—

A communicating branch, which passes over the internal maxillary artery to the lingual nerve.

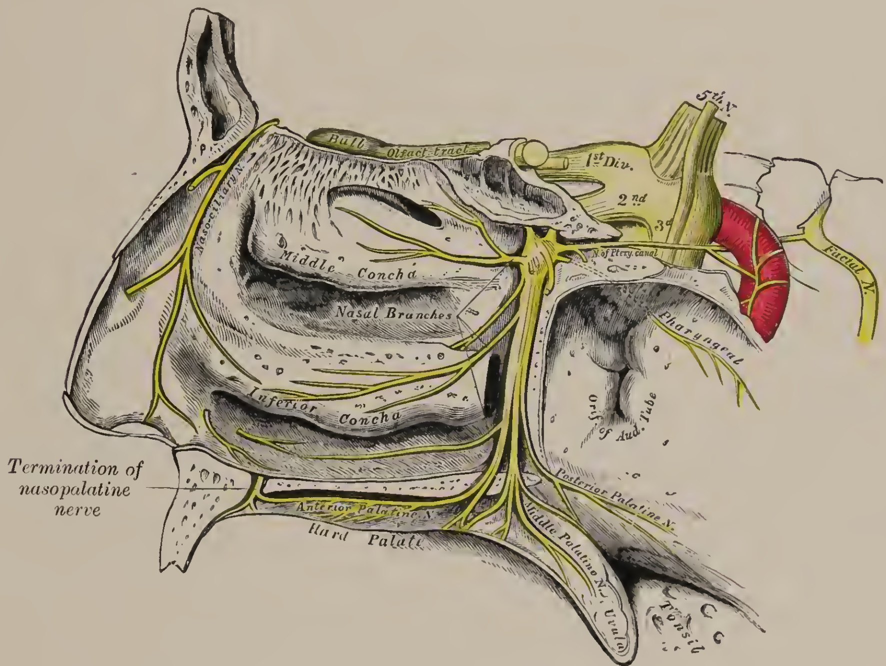


FIG. 129.—The sphenopalatine ganglion and its branches. (Gray.)

A mylohyoid branch, which is generally described with the inferior alveolar, which is a sensory nerve, while the former is in reality motor in character. Its fibers can be traced from its point of distribution backward to the anterior or motor root of the trigeminal It is given off from the inferior alveolar nerve just as it is about passing into the mandibular foramen, and passes downward and forward, accompanied by the mylohyoid artery in the mylohyoid groove of the mandible. It is distributed to the inferior surface of the mylohyoid and the anterior belly of the digastric, also the tensor palati and tensor

tympani muscles. A few filaments from this branch pass through the mylohyoid muscle and interlace with the lingual nerve. Branches are also described as passing to the triangularis (depressor anguli oris) and platysma muscles (Henle), to the integument below the chin (Krause and Schwalbe), and to the submaxillary gland (Meckel, Henle, Curnow).

The inferior alveolar branches are numerous, and fine filaments pass through the apical foramina in the roots of the teeth of the lower jaw to supply the pulp and tooth with sensation. There are also filaments which pass upward and supply the alveolodental membranes and gum tissue.

The incisor branch is the continuation of the main trunk of the inferior alveolar nerve.

The mental or labial nerve is the larger of the two terminal divisions of the inferior alveolar nerve. It passes outward from the mental canal through the mental foramen, and immediately breaks up into three branches beneath the triangularis muscle. The inferior branch descends, and is distributed to the chin. The two superior branches ascend to supply the lip, its mucous membrane, and the labial glands. These three branches freely interlace with the maxillary branch of the facial nerve.

SYMPATHETIC GANGLIA CONNECTED WITH THE TRIGEMINAL NERVE.

The sympathetic ganglia found in connection with the trigeminal nerve belong to the general sympathetic system found throughout the body. This sympathetic system is composed of a large number of ganglia, cords, and plexuses.

The ganglia are separate centres for the conveyance and distribution of various cords and filaments, consisting of motor, sensory, and sympathetic fibers. They contain nerve cells very similar to those found in the encephalon and spinal cord. These ganglia are arranged in two chains situated on each side of the body near the central line. They commence with the ciliary ganglion in the orbit, and extend

downward along each side of the vertebral column, and terminate below in the ganglion impar in the coccygeal region.

The ganglionic or sympathetic system is independent and separate from the general nervous system, but is intimately connected with it by communicating branches which pass from the motor and sensory roots of the cerebrospinal nerves, as well as by direct filaments which extend between it and the cerebrospinal centres. The sympathetic nervous system is distributed to the mucous membranes, the viscera, the coats of bloodvessels, and to the non-striated or involuntary muscular fibers. The nerves of this system form plexuses in various parts of the body, especially around the arteries. They are not found in connection with striated voluntary muscular fiber. The cardiac muscle being partially striated, yet involuntary, is an exception. Numerous ganglionic cells are found situated at the terminal ends of sympathetic nerve fibers.

The four pairs of ganglia associated with the trigeminal nerve are as follows:

Ciliary,	Otic,
Sphenopalatine,	Submaxillary.

The ciliary ophthalmic or lenticular ganglion is situated in the posterior portion of the orbital cavity, between the Rectus lateralis and the optic nerve, in close apposition to the ophthalmic artery. It is a small, flattened, and reddish body, surrounded by adipose tissue, its flattened surfaces being the proximal and the distal. It measures about 2 mm. in length anteroposteriorly.

Its branches or roots of communication are—

1. *The sensory or long root*, which is a slender filament arising within the cavernous sinus from the nasociliary nerve. It enters the posterior superior angle of the ganglion. Occasionally a filament is found which extends from the lacrimal nerve to the ganglion.

2. *The motor or short root*, which is shorter and thicker than the sensory root, and occasionally divides into two branches. It is derived from the inferior oblique branch of the motor oculi or third nerve, and joins the ganglion at its posterior inferior angle.

3. *The sympathetic or middle root*, which is derived from the system to which the ganglion belongs. This root is smaller than either of the

others, and originates in the cavernous sinus, being derived from the carotid plexus. Through this plexus it communicates with the cervical ganglion. As it extends forward to the posterior border of the ganglion, it occasionally unites with the long or sensory root, forming a common trunk.

Variations in the Roots.—The ciliary ganglion may receive accessory roots from the superior division of the motor oculi, the lacrimal, abducens, or sphenopalatine ganglion (Henle, Tiedemann).

"According to Reichart, the ciliary ganglion does not receive its sympathetic fibers by a single root, but by several fine filaments, the majority of which accompany the motor oculi.

"It appears from the mode of development and arrangement in many of the lower vertebrates that the ophthalmic ganglion is morphologically associated more intimately with the motor oculi, having, in fact, the significance of a spinal ganglion of that nerve (M. Marshall, Schwalbe)."[1]

Its branches of distribution are to the iris and ciliary muscles. The short ciliary nerves, ten to fifteen in number, arise in two sets, superior and inferior.

The superior set arises from the anterior superior angle, and passes forward, in a wave-like manner, between the optic nerve and the superior rectus muscle to the posterior part of the eyeball.

The inferior set is more numerous than the superior, and arises from the anterior inferior angle of the ganglion. It passes in a wave-like manner below the optic nerve and above the inferior rectus muscle to the posterior part of the eyeball. It is accompanied by the long ciliary nerves which are derived from the nasal branch of the ophthalmic division of the trigeminal. One or more of its fibers join the short ciliary nerves.

Both the superior and the inferior sets pass forward through the sclera of the eye in delicate grooves on its inner surface, next to the choroid, and are distributed to the ciliaris muscle, the iris, and the cornea. A small filament penetrates the optic nerve to the arteria centralis retinæ (Tiedemann).

[1] Quain's Anatomy.

Sphenopalatine Ganglion.—The sphenopalatine ganglion (ganglion of Meckel) (Fig. 129) is the largest of the ganglia associated with the trigeminal nerve. It is situated in the pterygopalatine fossa in front of the anterior opening of the pterygoid canal, close to the sphenopalatine foramen. It is triangular in form, with its apex pointing backward in the

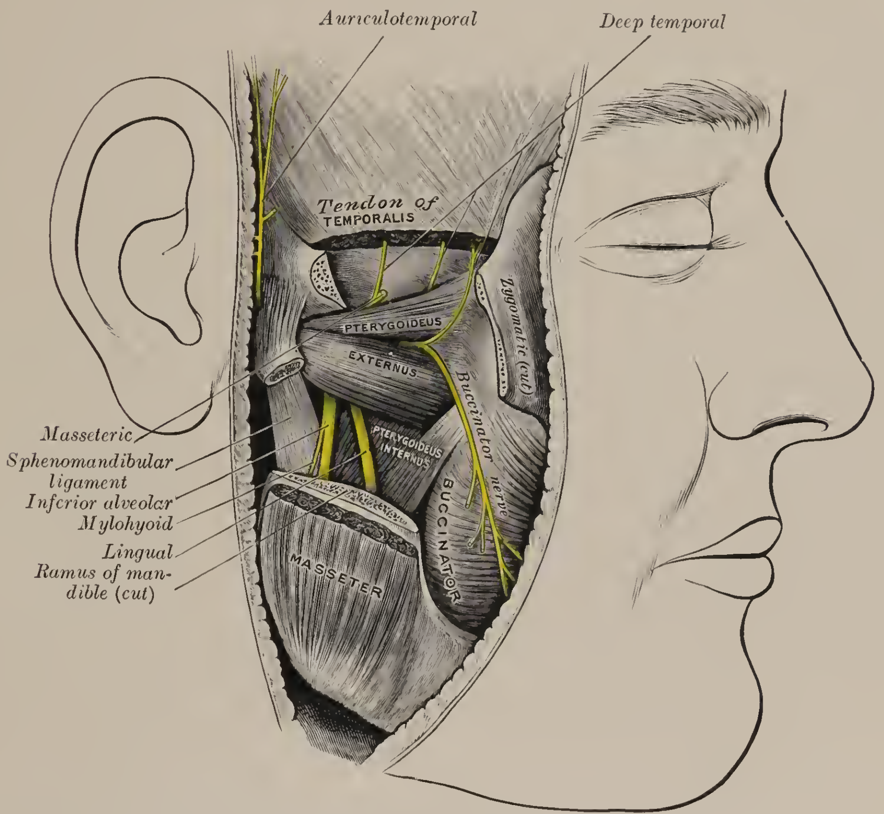


FIG. 130.—The pterygoideus externus and the branches of the mandibular nerve in relation to it. (Gray.)

direction of the pterygoid canal, and is surrounded by adipose tissue. Its outer surface is convex, and averages about 8 mm. in diameter. It is reddish-gray in color, except at its broadest part, where it is composed entirely of gray matter.

The branches or roots of communication of the sphenopalatine ganglion are—

1. *The sensory roots*, two in number, which arise from the maxillary nerve as it passes through the pterygopalatine fossa. They enter the ganglion separately, one at the anterior and the other at the posterior corner of the upper surface. Many of the fibers of these roots pass through the ganglion without becoming incorporated with it, and receive no influence from it. These fibers form the palatine nerves.

2. *The motor root*, which is quite long, and arises from the facial nerve or the greater superficial petrosal nerve at the genicular ganglion within the prominence of the facial canal. From this point it passes forward through the hiatus on the anterior surface of the petrous portion of the temporal bone, then inward beneath the semilunar ganglion, being separated from it by a thin layer of dura mater. It then pierces the fibrocartilage occupying the foramen lacerum and passes to the outer side of the internal carotid artery. At this point it is joined by the sympathetic root or the large deep petrosal nerve of the sphenopalatine ganglion, and the two conjointly are called the nerve of the pterygoid canal (Vidian nerve). They pass into the pterygoid canal in the sphenoid bone, extend through this canal, and at the exit enter the posterior or apical extremity of the ganglion. The gray matter of the ganglion extends along the nerve as far as the origin of the sympathetic at the carotid plexus.

3. *The sympathetic root*, or the large deep petrosal nerve, commences from the carotid plexus which surrounds the internal carotid artery. These filaments unite and form a short branch of reddish color and soft texture, which passes forward and joins the motor root of the ganglion to form the nerve of the pterygoid canal above described. Occasionally these two roots remain separate throughout their course, and enter the ganglion ununited.

The branches of distribution of the sphenopalatine ganglion are—

1. *Orbital branches*, consisting of three or four fine filaments which pass into the orbit through the inferior orbital fissure, and are distributed to the periosteum and mucous membrane of the posterior ethmoidal and sphenoidal sinuses by passing between the sphenoid and ethmoid bones.

Some of the branches which pass upward are distributed to the neurilemma of the optic nerve (Arnold and Longet).

A branch from the ganglion ascends to the sixth nerve (Bock and Valentin).

Also a branch to the ciliary ganglion (Tiedemann).

Two or three branches, sphenoethmoidal, ascend to the superior portion of the internal orbital wall, pass through the posterior ethmoidal foramen, and enter the brain-case (Luschka).

2. *The descending or palatine branches*, three in number—anterior posterior, and external. These three branches pass from the maxillary nerve through that portion of the ganglion in which there is little ganglionic or gray matter. They thus pass to their distribution with out becoming involved or influenced by the ganglion, except it be to a very slight extent.

The anterior or large palatine nerve passes downward in the pterygopalatine canal, and enters the oral cavity at the great palatine foramen. It then passes forward in a groove on the side of the hard palate to its anterior portion, where it joins the nasopalatine nerve. It is distributed to the gums, mucous glands, and membrane of the hard palate. This nerve gives off a separate branch (middle palatine), which passes downward to the soft palate in a separate canal. It also gives off branches (inferior nasal) while in the canal, which are distributed to the middle and inferior conchæ.

The posterior or middle palatine nerve passes downward, accompanied by a small artery in the small palatine canal, to the soft palate, and divides into two sets of branches. One set is distributed to the levator palati and musculus uvulæ, and may be composed entirely of motor filaments coming from the great superficial petrosal branch of the motor and facial nerves, and the nerve of the pterygoid canal. The other set, which is sensory, is distributed to the mucous membrane of the superior surface of the soft palate, the glands of the soft palate, and to the tonsils.

The external palatine nerve is the smallest of the three descending branches, and is not always constant in its existence. It passes downward through the external palatine canal, which is situated between

the tuberosity of the maxilla and palate bones, and is distributed to the tonsils, uvula, and outer portion of the soft palate.

The internal or nasal branches consist of two divisions, upper nasal and nasopalatine.

The upper nasal branches, four or five in number, are small, and pass horizontally inward through the sphenopalatine foramen into the posterior superior portion of the nasal chamber. They are distributed to the posterior superior portion of the nasal septum, to the mucous membrane covering the superior and middle conchæ and to the posterior ethmoidal cells.

The nasopalatine branch is larger than the upper nasal branches, and is an important division of the nasal nerves. It is long and slender, and arises from the proximal surface of the sphenopalatine ganglion. It passes through the sphenopalatine foramen across the roof of the nasal cavity to the septum, where it turns downward and forward, and extends in a groove or canal on the vomer to the foramina of Scarpa or nasopalatine foramina. These are two in number, anterior and posterior, and are situated in the intermaxillary suture. The nerve of the right side usually passes through the posterior foramen, while the nerve of the left side passes through the anterior. These two nerves (right and left nasopalatine), meeting in the incisor foramen, form a fine plexus, from which minute filaments are distributed to the palate posterior to the incisor teeth and interlace with the anterior or great palatine nerve. "In the course along the septum small filaments are furnished from the nasopalatine to the pituitary membrane."[1]

The posterior branches generally assume the name of the nerve of the pterygoid canal (already described) and the pharyngeal nerve.

The pharyngeal or pterygopalatine nerve consists of several fine filaments which frequently arise from the nerve of the pterygoid canal, instead of from the posterior portion of the ganglion. It passes downward through the pterygopalatine canal, accompanied by an artery of the same name, and is distributed to the mucous membrane of the upper portion of the pharynx and neighborhood of the auditory tube.

[1] Quain's Anatomy.

Otic Ganglion.—The otic ganglion (Fig. 131) is a reddish-gray body situated just below the foramen ovale, and in close apposition to the

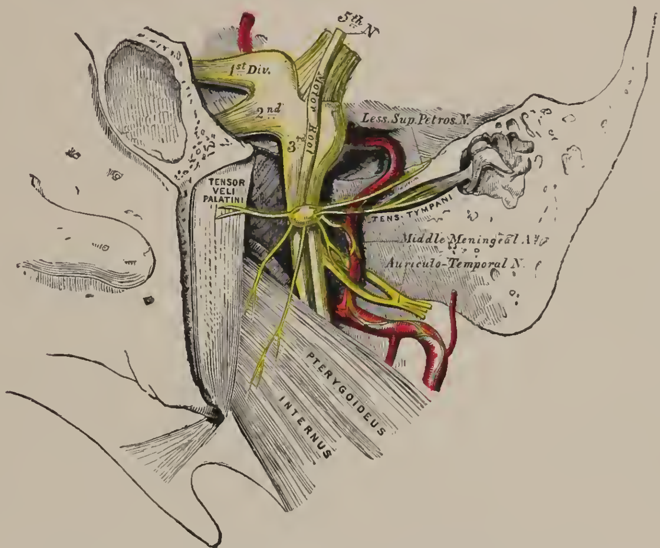


FIG. 131.—The otic ganglion and its branches. (Gray.)

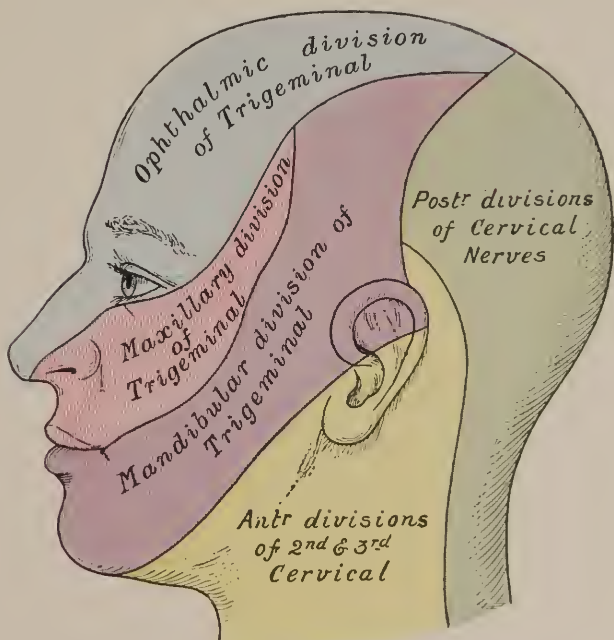


FIG. 132.—Diagram showing cutaneous areas of face and scalp. (Gray.)

proximal surface of the mandibular nerve at the point of union of its motor root with the third sensory division arising from the semilunar ganglion, with the cartilaginous portion of the auditory tube to its inner surface, while the middle meningeal artery passes up into the braincase just posterior to it. It is a flattened oval body, its widest diameter, which is about one-sixth of an inch, being anteroposterior.

Its branches or roots of communication are—

1. *The long or sensory root of Arnold* which is composed of the lesser superficial petrosal nerve, a continuation of the tympanic branch of the glossopharyngeal, and a branch from the geniculate ganglion of the seventh. The ganglion also receives an important sensory branch from the auriculotemporal nerve of the trigeminal.

2. *The motor or short root of Arnold* which is derived from the internal pterygoid branch of the inferior maxillary division of the trigeminal. It also receives motor filaments through the lesser superficial petrosal derived from the genicular ganglion of the seventh nerve.

3. *The sympathetic root,* which is derived from the plexus around the middle meningeal artery.

The branches of distribution of the otic ganglion supply in part the parotid gland, the chorda tympani, tensor tympani, tensor veli palatini muscles, and the mucous membrane of the middle ear.

The Submaxillary Ganglion.—The submaxillary or lingual ganglion is situated above the deep portion of the submaxillary mucosalivary gland, close to the outer portion of the hyoglossus muscle. It varies in shape and size, usually being triangular, but occasionally it is fusiform or plexiform, or absent altogether.

Its branches or roots of communication are—

1. *The sensory root,* which arises from the lingual branch of the mandibular nerve and enters the posterior portion of the ganglion.

2. *The motor or long root,* which is formed from the motor filaments of the lingual nerve received from the chorda tympani branch of the facial.

3. *The sympathetic root,* which arises from the sympathetic plexus around the facial artery.

The branches of distribution of the submaxillary ganglion are principally those that supply the submaxillary muco-salivary gland and its duct. Other branches pass upward, and interlace with the lingual nerve, forming a plexus on the side of the tongue, from which filaments are given off which supply the mucous membrane of the mouth. Baldwin and other anatomists describe a sublingual ganglion which is situated on the branch of the submaxillary ganglion which passes to the lingual nerve. Occasionally one or two small branches are found which communicate with the hypoglossal nerve (Meckel and Bose). None of the branches of the submaxillary ganglion are distributed to muscles, which is in marked contrast with the branches from the otic ganglion.

LOCAL ANESTHESIA OF THE TEETH, SURROUNDING TISSUE, AND PARTS OF THE FACE PRESIDED OVER BY THE TRIGEMINAL NERVE.

Local anesthesia may be obtained by several methods: by direct application of the drug to parts such as the mucous membrane of the mouth or nasal cavities, by hypodermic injection of moderate force, by forcing the anesthetic into the bone under high pressure causing infiltration through the bone cells, and by the conductive or blocking process. It should be borne in mind that no injection should ever be made in an infected area.

The ordinary hypodermic may be used, but where a deeper anesthesia is required it is necessary to inject with a stronger and larger syringe into the nerve at a place easy of access, between the point of operation and the sensorium; if for instance it was desired to anesthetize the lower lip "blocking" could be done at the mental foramen on each side. From examination of various mandibles in typical skulls it will be found that at puberty the foramen is in the centre of the body of the bone at a perpendicular line between the two premolar teeth (see Fig. 2); by studying this and other illustrations as well as specimens, one can judge the best point for injection within the vestibule of the mouth for this particular location. Though the mental foramen, its

canal and nerves are rather constant as to position and relation, (see Fig. 3) in very old age, if the mouth be edentulous, the mental foramen is often found nearer the top of the body of the mandible (see Fig. 4); there may be also modifying pathological conditions making it necessary to take into consideration, not only age but the many variations that are discussed in the general text. As all the mandibular teeth, gum tissue and most of the mandible are presided over by the mandibular nerve, the anesthetizing centre for this region would be the mandibular foramen which is one of the most constant features in anatomy.

The mandibular foramen is in the median surface of the ramus generally in the centre and placed obliquely, it is oval in shape with a sharp border of bone extending upward from the lower margin known as the lingula to which is attached the sphenomandibular ligament.

Above the foramen is a depression known as the mandibular sulcus, along which the inferior alveolar nerves and vessels pass into it. In front and medial to these is the lingual nerve (see Fig. 130). It is in the region of the sulcus that the point of injection should be carried for anesthetizing most of the lower jaw.

The blocking of the nervous system is more complicated in the maxillary region than in the mandibular as the courses of distribution are more intricate, for this reason the minute knowledge of the variations in the anatomy of this region should be acquired before one can intelligently and accurately anesthetize the middle portions of the face. The reflexes of the various ganglions and interlacing of the nerves either complicate or assist in proportion to the operator's knowledge of the distribution of this nervous system.

If the maxillary nerve, as it passes through the pterygoid palatal fossæ, be blocked before it branches to the sphenopalatine ganglion, all the structures in front of this region would be deprived of sensation, this might not be desirable. For local operation upon the middle face the ordinary points of injection are the infraorbital foramen, the incisive foramen, the greater and lesser palatine foramina, and the alveolar foramina. The infraorbital foramen is not constant in position as it may be found just under the middle of the infraorbital ridge or it may

be lateral to this and much lower down, the location of point of injection can usually be detected by careful digital examination in the vestibule of the mouth going upward over the premolar teeth.

The incisive foramen, a funnel-shaped opening, is situated immediately back of the two first incisors. It is in the interpremaxillary suture just anterior to the palatal process of the maxillary bones, four canals usually lead into it from the nasal cavities, two incisive canals or canals of Stenson, for the accommodation of the descending palatine arteries, and two canals of Scarpa, anterior and posterior, for the accommodation of the nasopalatine nerves. This foramen is the most easy of access.

The greater and lesser palatine foramina are situated near the lateral and posterior edge of the hard palate, to the inside of the third molar. The greater palatine foramen is the outlet to the pterygopalatal canal and conveys the anterior palatine nerve which passes forward in a groove in the hard palate to the incisive foramen, interlacing with the terminal filament of the nasopalatine nerve. The two lesser palatine foramina are for the passage of the middle and posterior palatine nerves.

The alveolar foramina are much more difficult to reach as they are not constant in either number or position, it is for this reason that the same result is not always obtainable in anesthetizing. They are situated in the infratemporal surface of the maxilla and transmit the superior alveolar nerves and vessels. The best point for injection is back of the tuberosity along the posterior wall of the maxillary sinus; all branches of these nerves should be blocked as they preside over the maxillary molars, premolars, and canine teeth. To reach the maxillary incisors the injection should generally be made in the infraorbital foramen.

CHAPTER VI.

TEETH INFLUENCED BY IRREGULAR ERUPTION.

RETARDED ERUPTION OR IMPACTED TEETH.

Deformed, impacted and misplaced teeth should be studied not only as showing evidences of diseased conditions in themselves, but they must be regarded as symptoms of some precedent pathological disturbance which has manifested itself, among other ways, in these anomalies. One must know the history of the development and growth of the face, as well as of each individual tooth, in order to trace the period of the early pathological condition which caused the deformity. It frequently happens that at the same time other facial disturbances may be produced, which could in this way be indicated and traced by recognizing the relationship between the causative pathological lesion and its various manifestations.

Precise diagnosis of the many obscure diseases associated with the face is impossible without accurate knowledge of the anatomy of the head—even to each individual tooth. This knowledge must include the various characteristics exhibited by the anatomy at different periods of life, and the effect of early pathological conditions on the anatomy of the teeth, jaws and face generally.

Among the general pathological disturbances which bring about deformity or retarded eruptions of the teeth may be mentioned syphilis, the acute exanthemata such as scarlet fever, etc., and disorders of nutrition. Among local causes are inflammations of the jaw bones set up by carious teeth or other disturbances, deformed arches, etc. The growth of the jaws and the movement of the teeth is in a forward direction, consequently anything which interferes with this forward movement will cause anomalous eruption and impaction of the teeth and deformity of their roots. Chronic conditions resulting from any of

the acute exanthemata may interfere with the proper development by causing an excessive deposit of salts of calcium, inducing a hyperplasia, which may either be general or localized within the cancellated bone.

The roots of misplaced teeth are often curved in abnormal shapes, or, in the case of molar teeth, compressed together. They are not actively bent into these positions, but are built or formed thus in the process of growth. They are often held in the place of development, or pushed in the direction of the least resistance, until resorption of the bone tissue occurs, when they usually make their appearance in an abnormal position.

The increase of density of the bone not only prevents the teeth from taking their normal positions, but compresses the vessels and nerves, producing local malnutrition and general discomfort, not always severe enough to be called neuralgia, although, on the other hand, this disturbance is sometimes so severe as to incapacitate the individual from doing any kind of mental work.

Local increase in the density (sclerosis) of the bone may also be brought about by inflammation of the periodental membrane, extending into the alveolar process. Thus the cancellated tissue, instead of being spongy, and elastic, becomes hard and solid (see Fig. 45). This condition, following caries of the first permanent molar soon after its eruption, is sometimes a cause of impaction of the third molar. The severe traumatism to the jaw may cause a deposit of salts of calcium in the cancellated tissue, and thus bring about impaction. A heavy blow on the chin in childhood has produced ankylosis of the mandibular joint, resulting in arrest of growth of the jaw, and leaving insufficient space for eruption of all the teeth. Premature extraction of the deciduous teeth, or the neglect to extract them at the proper time, may cause malposition of the permanent teeth, this leading in turn to impaction of unerupted teeth. Failure to freely lance the gums in retarded eruption of the deciduous teeth is also a frequent cause of an abnormal density in the cancellated tissue of the jaw.

Impacted teeth may be present without giving rise to any local symptoms whatever, but as a usual thing they are a cause of many serious local and often far-reaching general disturbances.

Magitot[1] reports many cases of deformed supernumerary, misplaced, transposed and impacted teeth in man, monkey, horse, and other animals. These are fully described and illustrated in the pages of his valuable and important work, to which the interested reader is referred.

Figs. 133 and 134 give the under surface of a monkey's skull,[2] with the occluding surface of the mandible showing two impacted premolars in the roof of the mouth near the intermaxillary suture.

Fig. 133

Fig. 134

Figs. 133 and 134.—Monkey's skull, showing two impacted maxillary premolars.

Figs. 135 and 136 are from an *x*-ray picture of the same skull, showing the impacted teeth and their roots, also the developing canines in the upper jaw.

[1] Traité des Anomalies du Système Dentaire, Paris, 1877.
[2] From Dr. Kirk's collection.

Local Effects.—An impacted third molar may press against the crown of the second molar and dental caries may be indicated in this tooth, or itself become the seat of caries around the point of contact. Before the devitalization of pulp severe facial neuralgia may occur. Again, the irritation set up by an impacted tooth may cause a condensation of the surrounding bone with pressure on the mandibular nerve and its branches which ramify through the bone. Failure to recognize the local cause may lead even to serious and dangerous operations on the semilunar ganglion. No case of facial neuralgia should be operated upon without search for a possible local cause.

Fig. 135

Fig. 136

Figs. 135 and 136.—*X*-ray picture of the same as shown in Fig. 133.

Infection from a pulp devitalized by an impacted tooth in the upper jaw, may pass up into the maxillary sinus and other pneumatic spaces. An impacted lower third molar, in its attempt to erupt, fre-

quently causes a cellulitis which extends into the region of the mandibular joint, causing acute ankylosis. It may also set up tonsillitis, pharyngitis, dysphagia and even trismus, if suppuration takes place around it. Rarely, infection may extend from the dental and maxillary veins, through the pterygoid plexus to the cavernous sinus.

General Effects.—It has been well established that impacted teeth and the antecedent pathological condition of the bone may be a source of great disturbance of the whole nervous system. Cases can be cited of serious disturbances of the nervous system being cured by the removal of impacted teeth and also by the removal of hard bone which has become consolidated by an excessive deposit of salts of calcium within the spongy or cancellated tissue.

Diagnosis.—The diagnosis by superficial observation of many of these conditions of the mouth, and even of the internal structure of the face, is comparatively easy. The general character of the erupted portion of a tooth, its position, and the firmness with which it is held in the alveolar process, can be studied with the aid of a mouth mirror and a few dental instruments, provided that the surgeon has a minute knowledge of both the typical and abnormal anatomy of this region. The same qualification is demanded in using the *x*-rays for diagnosis of the more obscure diseases. No matter how good a skiagraph be obtained it is useless unless the reader can distinguish the pathological from the normal condition, which demands that he must know the many deviations from typical anatomy that even a normal condition can present.

Value of X-ray Pictures.—The *x*-rays are of inestimable value when used in conjunction with other means in the diagnosis of the more obscure abnormalities of the teeth. There are many times, in fact, when an intelligent interpretation of the case would be impossible without the use of *x*-rays in locating the abnormal or diseased condition. Instances could be cited of patients suffering from severe neuralgia who had been treated, without success, with opiates and other drugs, because no local cause had been suspected, or in whom the symptoms had been ascribed to remote causes, when the skiagraph revealed an impacted tooth, the removal of which brought about immediate and permanent relief.

In the case of the lower third molar the question of the advisability of removing the impacted tooth or the one next to it, is often settled by a good *x*-ray picture; thus, where the *x*-ray shows that the adjacent tooth has been damaged and that the impacted tooth could easily erupt to take its place, extraction of the former would be indicated and only one tooth sacrificed instead of two.

Fig. 137[1] gives a general idea of the arrangement and position of the deciduous and permanent teeth, and of their relations, about the

Fig. 137.—Skull of a child, aged about six years, showing all the deciduous teeth in position and the developing permanent teeth.

sixth or seventh year. The external walls of the alveolar process of the upper and lower jaws have been removed, together with some of the cancellated tissue, exposing the roots of the deciduous teeth and the crowns of the permanent ones. It will be noticed that at this age nearly all of the space of the maxillary bone is occupied by the dental organs, there being but little room for the maxillary sinus. It would seem clear, that by interference with the natural processes

[1] For further description of this illustration, see Fig. 107, of which it is a repetition.

at this period of life, the permanent teeth can be deflected or detained from assuming their normal positions, thus modifying the shapes of the maxillary sinus or nasal cavities. When these chambers are changed in form, size, or position, associated cavities and adjoining structures will also be changed. The shape of the orbit may also be modified to such an extent that the eye may be affected, making it myopic or hypermetropic. In this figure the crown of the upper first molar is visible. The position of the germs of the second and third molars is higher up and further back, therefore they must be close to the

FIG. 138.—Side view of the upper and lower jaws of a child about seven or eight years of age, showing the deciduous teeth, the first molars, and the germs of other permanent teeth.

under surface and posterior portion of the orbit. This was interestingly demonstrated by a patient referred to the Department of Dentistry of the University of Pennsylvania, who had an impacted upper third molar, the crown of which was in the upper portion of the posterior wall of the maxillary sinus. (See Fig. 142.)

Fig. 138 is from a specimen of the upper and lower jaws of a child about seven or eight years of age. All the deciduous teeth are in position except the incisors. The first molars have erupted, the other permanent teeth are in fairly normal position for this age.

Fig. 139 is from a similar preparation of a child about twelve or thirteen years of age. It will be noticed that the position of the roots of the upper first and second premolars and the roots of the first molar have been interfered with by some pathological condition.

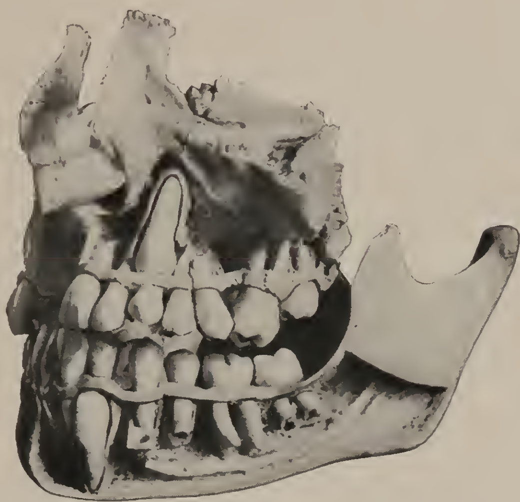


Fig. 139.—Side view of upper and lower jaws of a child about twelve or thirteen years of age.

SUPERNUMERARY TEETH.

The development of a supernumerary tooth or teeth may also cause impaction of a normal tooth. Two marked cases have come under the writer's observation, the first in a skull belonging to Dr. Kirk's collection, where thirteen small supernumerary teeth are developed in the position of the root of the left upper first incisor, which was found, upon dissection, to be impacted between the floor of the nose and the roof of the mouth. The other case was in the mouth of a patient of Dr. Huey's, of Philadelphia, where thirty-five small supernumerary teeth were found within the alveolar process, in the space which should have held the left central incisor. After removing the supernumerary teeth, the permanent normal incisor could be seen resting between the plates of bone forming the roof of the mouth and the floor of the nose.

Fig. 140 is a photograph from a skull in Dr. Kirk's collection. It affords also a good idea of the general condition found in the mouth of Dr. Huey's patient. The permanent first incisor was not removed when the supernumerary teeth were extracted, as Dr. Huey and the writer had some hopes that it would assume its normal place with the other teeth. Six months after the operation the tooth had advanced more than half its length, and eighteen months later it descended into its normal position.

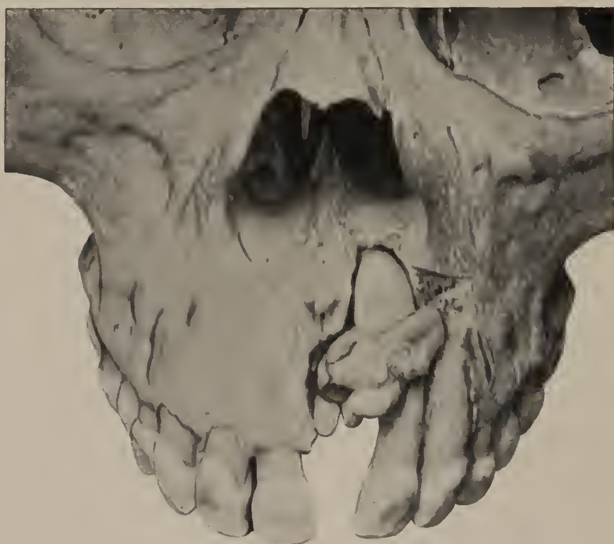


Fig. 140.—An odontoma and an impacted first incisor.

Fig. 141 is an illustration of the first incisor and supernumerary teeth taken from the skull shown in Fig. 140.

Fig. 142 is an illustration made from a section giving an idea of the position of the tooth in this patient's mouth. If this crown, as shown in the illustration, had roots of normal length, they would extend back across the sphenomaxillary space, the points of the roots would be near the sphenoidal sinus, and the roots would more than likely be covered by a thin lamina of bone developed from the original tooth sack or capsule of the maxilla. In cases where teeth have been found impacted in the upper part of the maxilla, similar to that shown in this illustration, they are

commonly spoken of as having passed upward. This, in the opinion of the writer, is incorrect. It is more likely that many of the teeth so found impacted have never passed down from their place of develop-

FIG. 141.—Views of the impacted tooth and odontoma removed from the jaw illustrated in Fig. 140.

ment. In this particular case, through some inflammatory process, the tooth and its capsule became adherent to the posterior wall of the maxilla, the intrinsic force being insufficient to force the tooth into

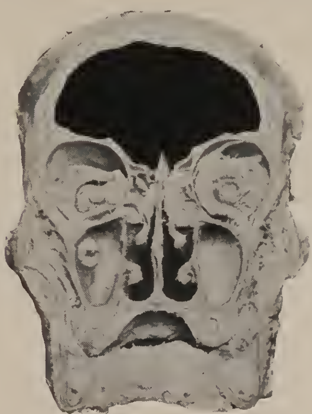


FIG. 142.—An illustration representing an impacted tooth in the posterior wall of the maxillary sinus.

FIG. 143.—A first and second incisor, and a canine tooth removed from the maxillary sinus of a patient who had been suffering with neuralgia.

proper position at the time it should have made its descent. It is somewhat analogous to an adherent testicle in the abdominal cavity or in the inguinal canal. There is no more reason to think that the tooth

passes upward than that the testicle passes up from the scrotum into the inguinal canal or abdominal cavity.

FIG. 144.—An impacted canine tooth with the apex of the root within the nasal cavity.

FIG. 145.—External wall of the nasal cavity, seen from the inside, showing the apex of the impacted canine tooth illustrated in Fig. 144.

Fig. 143 represents three impacted permanent teeth, first and second incisor, and canine, which were removed from a living patient suffering from neuralgia and sinusitis.

Fig. 144 is taken from a specimen which belonged to Professor James Truman's collection. It shows an impacted right canine, the external bone has been cut away, exposing the tooth and its root. The tooth is a little below the place of development. The apex is curved forward and inward, the inward portion passing just into the nasal cavity as shown in Fig. 145. A little external to the apex of the root is an opening into the maxillary sinus.

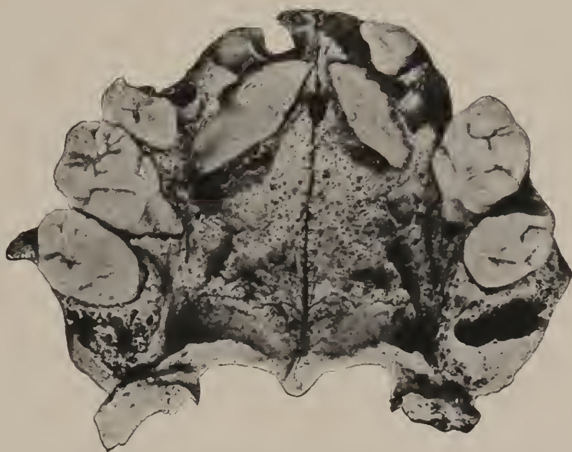


Fig. 146.—Two impacted canine teeth. Their malposition caused the loss of the left first and second premolars, also the loss of the right first premolar.

Fig. 145 is a view from the other side of the specimen seen in Fig. 144, showing the apex of the impacted canine in the external wall of the nasal cavity.

See Fig. 178 for impacted canine with crown immediately over the socket of the right first incisor, the root passing upward and backward.

Fig. 146 shows two canines impacted in the upper jaw, lying at nearly right angles to each other. They were entirely covered with bone, and were exposed by a surgical bur. The end of the root of the right canine is somewhat curved. There is only a slight layer of bone between it and the floor of the sinus. The layer of bone is perforated

by three small openings. This malposition caused the loss of the left first and second premolars, also of the right first premolar.

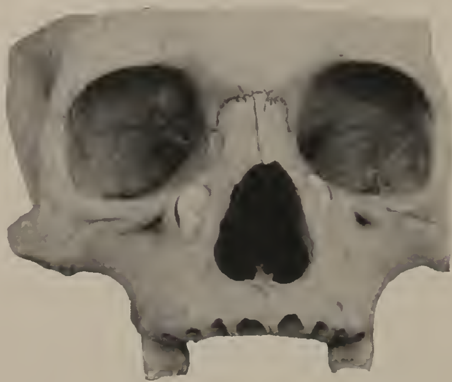


FIG. 147.—Showing two inverted canine teeth.

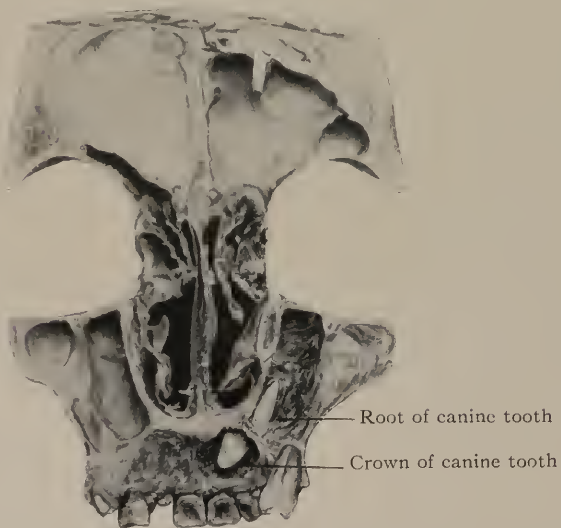


FIG. 148.—An impacted canine tooth, the crown in the roof of the mouth, the greater portion of the root in the maxillary sinus.

Fig. 147[1] shows two inverted canine teeth in the inner and lower border of the orbital margin. This class of impaction would interfere with the function of the nasolacrimal duct.

[1] This picture was presented by Dr. John Gravers' University of Utrecht, Holland.

Fig. 148 is a posterior view of a transverse vertical section of a face, made in the region of the first premolar teeth. Besides other interesting points, the crown of the canine tooth has penetrated the palatal surface of the mouth and the root is within the anterior portion of the sinus. Before the dissection was made, the root was covered with a thin lamina of bone. Similar conditions are often found, involving not only the canine tooth, but also the third molar, and occasion-

Fig. 149.—An x-ray, showing impacted right canine.

ally other teeth, which often remain in such positions for years without giving any trouble until after middle life, when by natural resorption of the bone the crown and root become exposed within the maxillary sinus or nasal cavity, at which time they may cause some disturbance.

Fig. 149 is an x-ray picture giving anterior view of a dried skull. It shows an impacted canine tooth with the crown resting against

the roots of the first and second incisor teeth. The roots of the first molar appear to be within the maxillary sinus, although they are in normal position. This impression is produced by the thinness of the lateral walls of the sinuses which only slightly resist the passage of the x-rays. When a canine tooth is in this position it should be extracted,

Fig. 150.—*X*-ray showing an inverted maxillary third molar. (*X*-ray by Dr. Pancoast.)

as it would probably cause devitalization of one or both of the incisors, and should the pulp become infected, the disease might extend to the maxillary sinus. Teeth in this position often cause serious systemic trouble.

Fig. 150 shows the occluding surface of the upper third molar pointing upward toward the posterior portion of the orbit. The patient

had been suffering from disturbance of the left eye for a long time. Considerable improvement took place in the eye soon after the extraction of the inverted tooth.

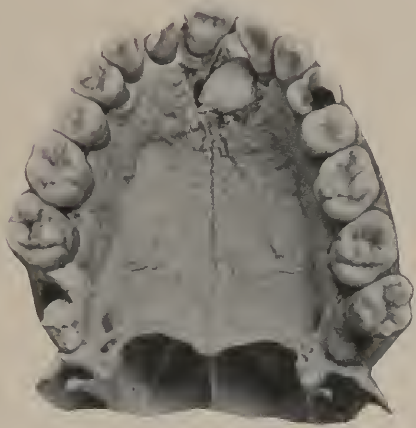


FIG. 151.—An impacted first incisor, with the crown partly in the incisive foramen.

FIG. 152.—An impacted supernumerary tooth.

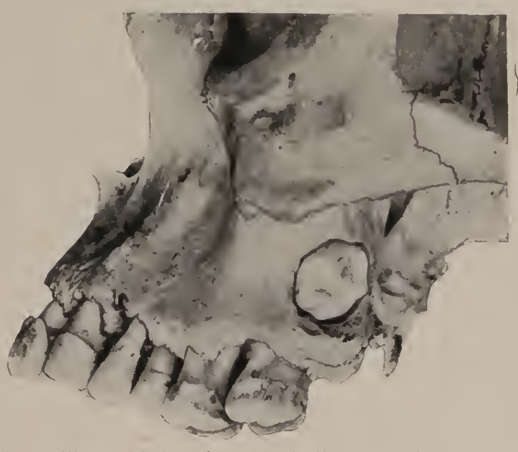


FIG. 153.—An impacted maxillary third molar. A similar condition is found on the opposite side of the skull.

Fig. 151 illustrates an impacted left first incisor, which lies diagonally across the alveolar process, with the apex of the root near the

outer side of the left anterior nares. The crown passes across the incisive foramen. Impaction of this kind would more than likely interfere with the true function of the nerves and vessels passing through this foramen.

Fig. 152 illustrates a supernumerary second incisor impacted immediately below the floor of the nose. There was no enlargement of the external plates of the incisive fossa, the floor of the nose, or the roof of the mouth. The tooth was accidentally discovered when cutting the bone transversely.

FIG. 154.—From a Philippine skull, showing an impacted maxillary third molar.

Fig. 153 exhibits an impacted and misplaced third molar. The occluding surface of the molar was even with the external plate of the alveolar process, the roots being compressed and somewhat shorter than normal. A complete thin layer of bone made a conical-shaped partition between the tooth sockets and the sinus. A similar condition existed on the opposite side of the jaw.

Fig. 154.—Made from the right side of a Philippine skull in Dr. Ketcham's collection. It shows a similar condition of impaction of the maxillary third molar to that in the Caucasian skull, Fig. 153.

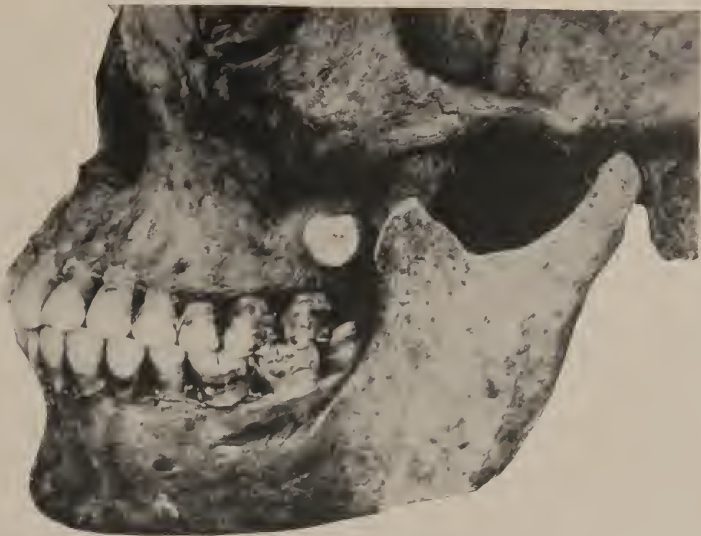


FIG. 155.—Is from the left side of the same skull as shown in Fig. 154.

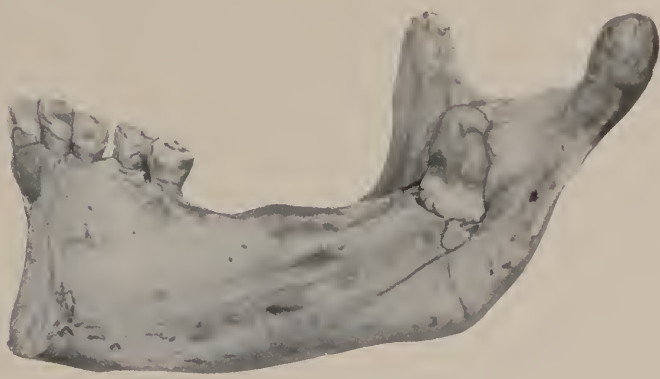


FIG. 156.—An impacted mandibular third molar.

Fig. 156 exhibits an impacted mandibular third molar in the ramus of the jaw just below the anterior portion of the mandilular notch, the tooth being inverted. In this case the capsule of the germ of the tooth

became adherent to the walls of the jaw, and lost its position within the forming cancellated tissue, when the body of the jaw grew downward and forward.

Fig. 157 shows a molar tooth in the ramus of the mandible. There is a light area around the greater portion of the crown. Teeth in this position in the living subject often give considerable trouble and their existence is very difficult to diagnose without the use of *x*-rays.

Fig. 158 illustrates the most common kind of impacted lower third molar teeth. They often give great trouble by irritating the inferior alveolar nerve. They may also cause an inflammatory condition in

FIG. 157.—*X*-ray showing misplaced mandibular third molar. (Kirk.)

this region, and the cellulitis may extend to the mandibular articulation and the base of the tongue.

Figs. 159 and 160 represent a similar impaction. In Fig. 160 the external portion of the bone covering the tooth has been removed, and in Fig. 159 the internal portion. In both cases it will be observed that the mandibular canal is encroached upon. It is often necessary to cut away a portion of the bone with the surgical engine before a tooth so situated can be removed.

Figs. 161 and 162 give two views of an impacted third molar. In Fig. 161 the tooth is in position as discovered when the cap of bone was removed; in Fig. 162 the tooth is removed from its socket, showing its inner surface. Its crypt is also seen. The second molar is a pulpless

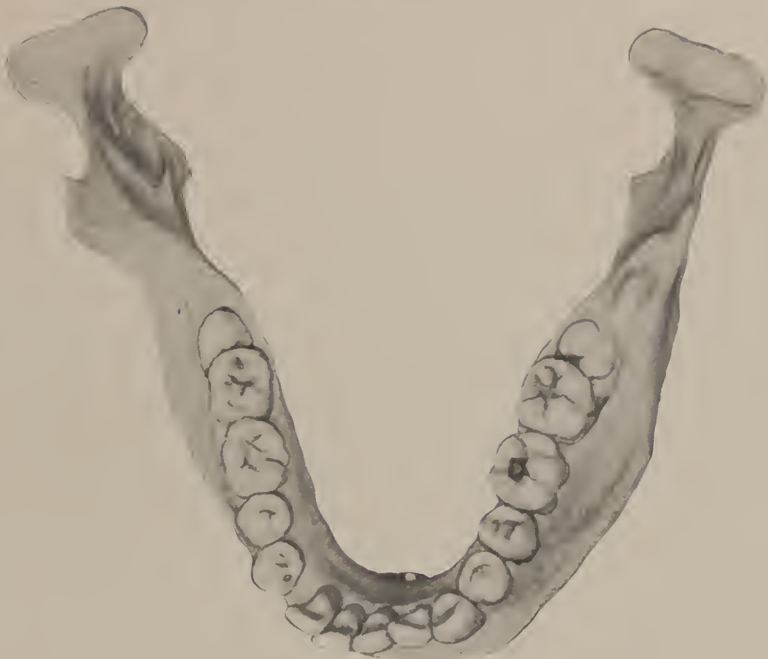


FIG. 158.—A common form of impacted lower third molars.

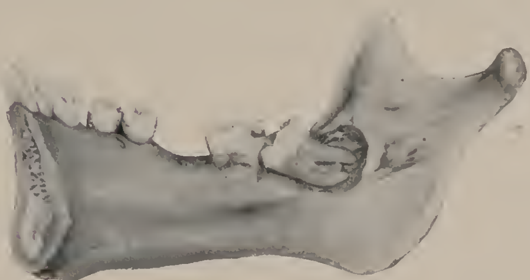


FIG. 159

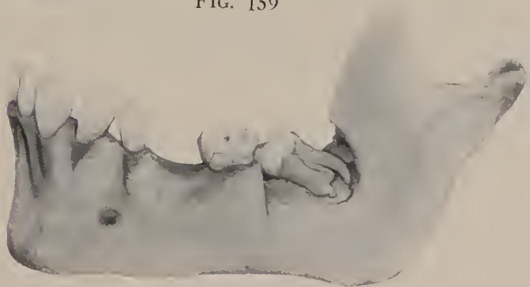


FIG. 160

tooth, the posterior root of which shows where the impacted tooth has pressed against it, causing resorption of a portion of the root until the

Fig. 161

Fig. 162

Figs. 161 and 162.—Two views of an impacted lower third molar. Upper figure shows tooth in position; in lower figure the tooth is removed from its pocket. Part of the posterior root of the second molar has been resorbed, exposing the root-canal, more than likely causing the devitalization of the tooth and thus producing neuralgia, induced by the pressure from the impacted tooth.

pulp-canal was fully exposed. The enamel of the impacted tooth is somewhat lost by friction against the second molar. The roots of the

impacted teeth have a slight curve inward at their points; the concavity fits immediately over the alveolar or mandibular nerve, and has probably caused pain by pressure. The terminations of the roots

FIG. 163.—*X*-ray picture, showing an impacted second mandibular premolar tooth. (*X*-ray by Dr. Pfahler.)

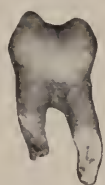


FIG. 164.—Showing the resorption of the roots of the first mandibular molar (Fig. 163), where the crown of the second premolar had pressed against the roots.

are not fully formed, the apical openings being large; it will also be noticed that the roots of the teeth in the jaw are longer than usual, that of the canine, for example, passing below the alveolar or mandibuar nerve.

Fig. 163, from an x-ray picture, showing an impacted second right mandibular premolar, its crown is resting against the roots of the first

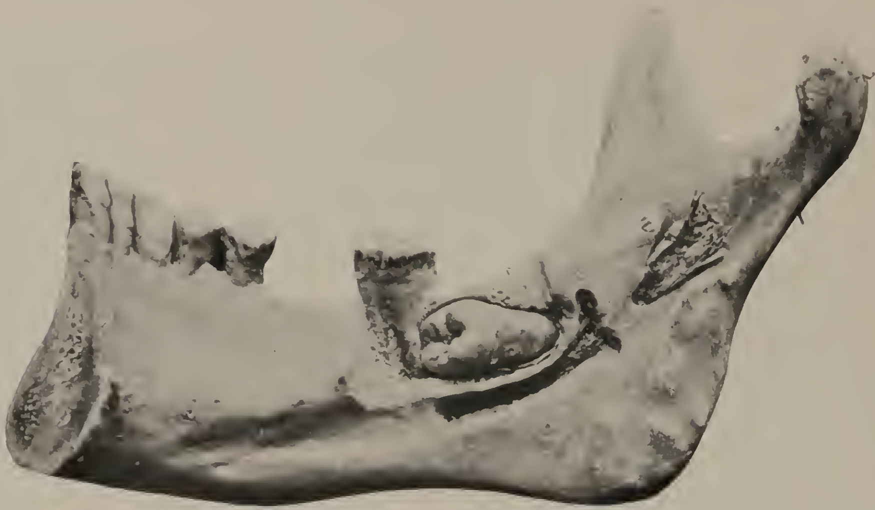


Fig. 165

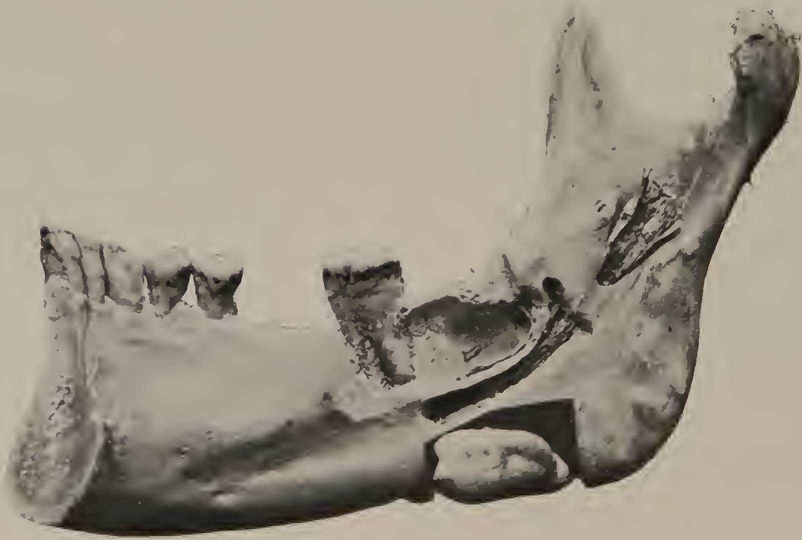


Fig. 166

Figs. 165 and 166.—Two views of an impacted mandibular third molar. In Fig. 165 it is in its abnormal position; in Fig. 166 it is taken from its crypt.

molar and has caused resorption of the ends of the roots as shown in the extracted tooth (Fig. 164).

Figs. 165 and 166 represent another impacted third molar, situated on the inner side of the jaw and pointing slightly downward. The posterior root of the second molar is slightly resorbed. Upon uncovering the tooth and taking it from its crypt, it was found to be incased in a thin shell of bone, as though the dental capsule had ossified separately around the tooth. The inner portion of the shell is still in position, the nerve and its accompanying tissues are seen passing into

Fig. 167.—An impacted mandibular third molar, and a mandibular third molar with curved and thickened root, both belonging to the same jaw. The bone is much more compacted than normal bone.

the mandibular foramen and immediately under or against the shell. Here, again, must have been an obscure cause of neuralgia.

Figs. 167 and 168 illustrate the right and left halves of the lower jaw, Fig. 167 showing the internal surface of the right half, while Fig. 168 shows the external surface of the left half. In the former we find the roots of the third molar curved backward at almost a right angle, and enlarged by an abnormal deposit of cementum until the independent character of the roots is lost, the two being fused together.

Fig. 168 shows an impacted tooth pushing directly against the

tooth in front of it. The roots of this tooth have also become much enlarged by deposit of cementum, while the surrounding bone has thickened and grown more compact.

FIG. 168.—An impacted mandibular third molar, and a mandibular third molar with curved and thickened root, both belonging to the same jaw. The bone is much more compact than normal bone.

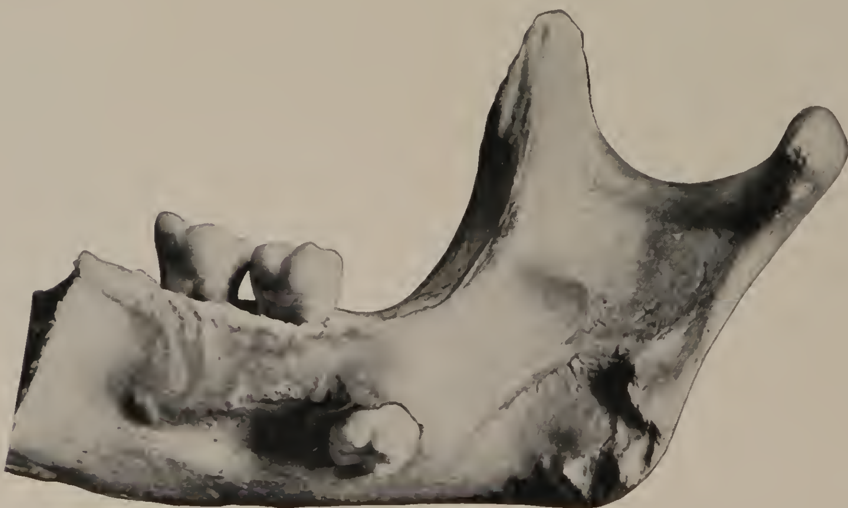


FIG. 169.—A mandible showing an inverted lower third molar erupting into the right submaxillary fossa. (Dr. Whitney.)

Fig. 169 gives an illustration where the mandibular third molar has become inverted and is erupting into the submaxillary fossa.

Fig. 170[1] is from an x-ray picture showing impaction of the second and third right mandibular molars, it is possible that the third is between the first and second molars.

FIG. 170.—An X-ray picture of a patient of Dr. A. R. Cook, of Syracuse, N. Y., it shows impacted second and third mandibular molars.

Extraction.—It would have been almost impossible to extract either of the two last-named third molars without fracturing the jaw, unless the solid bone over the roots of the teeth had been removed first. In a case of this kind, it is much better to use the surgical engine bur than to cut or break the parts away with chisel

[1] From a patient of Dr. A. R. Cook, Syracuse, N. Y.

or forceps. A fracture at this point will cause serious results; the mylohyoid artery is liable to be lacerated or even severed, and the hemorrhage is difficult to control. It is not easy to keep the region clean or aseptic, and the consequent inflammation will often interfere with free movement of the jaws in deglutition, speech, etc. The glottis even may become closed.

Diagnosis.—Impacted teeth are frequently the obscure or hidden cause of various diseases about the mouth and jaws. There is often no external evidence of their impaction; patients may even claim that the teeth which cannot be seen have been extracted.

Impacted incisors are liable to induce diseases of the nose or to produce neuralgia by the tooth pressing the sphenopalatine nerve as it passes through the incisive foramen. Occasionally they cause a partial separation between the septum and the nasal floor. Impacted teeth may become either partly lodged in the inferior meatus, sometimes causing the closure of the lower portion of the nasolacrimal duct, or they may lie horizontally across the roots of the incisors, especially of the second, or the roots of the premolars, causing the devitalization of these teeth. Impacted upper third molars are liable to interfere with the nerves and vessels in the floor of the maxillary sinus, near where they pass through the superior alveolar foramina into the sinus. They may also cause an enlargement of the tuberosity outwardly until it interferes with the ramus of the lower jaw, and produces a cellulitis which may extend to the mandibular articulation, causing false ankylosis.

Neuralgia.—The three impacted teeth shown in Fig. 143 caused a baffling case of facial neuralgia until they were found and removed. The patient was past middle life and had suffered from neuralgia. He had no teeth in the alveolar process of the right maxilla, the region of pain, almost all of them having been extracted in the hope of giving relief. The sinus was opened by the late Professor Garretson and the writer in search of the cause. It was somewhat surprising to see three crowns protruding into the sinus, the roots being imbedded in the inner anterior angle of the wall of the maxillary sinus. After the teeth were extracted by small forceps the parts were treated in the usual

way, with relief and subsequent cure. The crowns were in normal shape and quite healthy, the roots more or less defective. The pulps were alive, and it is probable that the nerves were impinged upon at the points of the roots, thus causing the pain. The writer has seen several cases where a greater portion of the root of a single tooth was found within the antrum; but he believes this to be the only case where three such teeth have been reported. In the lower jaw impacted teeth are liable to impinge upon the mandibular nerve, thus becoming a hidden cause of neuralgia in this region, which may have its symptoms exhibited almost anywhere along the distribution of the nerves, eventually producing neuritis that may pass back along the nerve even into the brain.

Cysts.—Teeth prevented from passing in their normal course may, through the resorption of the bone, advance in almost any direction and be erupted through the bone even upon its cervical aspect. Impacted or supernumerary teeth may also produce dentigerous cysts of various sizes and forms, some of which may cause the cortical portion of the bone to be pushed outward until large disfiguring tumors are formed. These have sometimes been mistaken for malignant growths, and the entire body of the jaw has been removed on account of this enlargement and mistaken diagnosis.

There is considerable confusion in the nomenclature of tumors arising from the dental follicle. A dental cyst is understood by the writer to be one originating from remains of the embryonic epithelial elements of the peridental membrane. These epithelial "rests," as a result of septic infection of the tissue, rapidly proliferate, the central portions degenerate, and ultimately liquefy, thus giving origin to the cystic fluid. A dental cyst is lined with cortical epithelium, which in some instances may become ciliated. A dentigerous cyst is understood to be a growth brought about by tissue changes occurring in the dental capsule during developmental periods; as the name implies, it contains one or more teeth.

The *x*-rays are the most valuable means of diagnosis. In both cases the principles of treatment are the same. This consists of evacuation of the fluid and solid contents of the cyst, and complete removal of

the cyst wall, which, as already noted, partially or entirely is lined with epithelial cells. If the cyst wall be not completely removed, these epithelial cells will continue to secrete fluid, and may proliferate with possibly the development of a malignant growth. The great majority of dental and dentigerous cysts can be removed through the mouth,

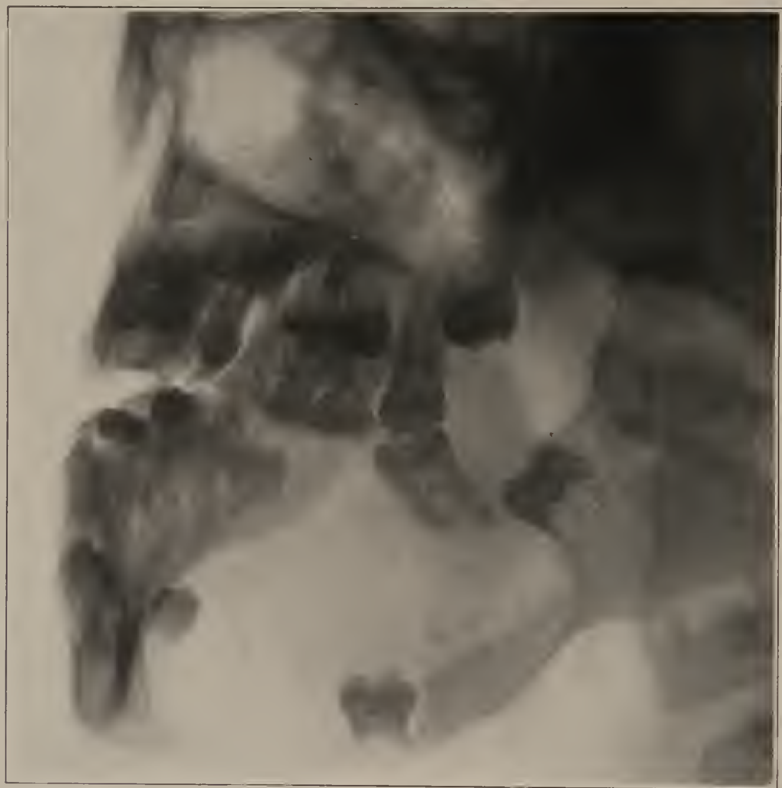


Fig. 171.—*X*-ray picture from a child aged nine years, showing a retained deciduous second molar surrounded by an ovoid clear area which probably partook the nature of a follicular odontome.

without operations on the face, and without destroying the continuity of the jaw bone, in case of involvement of the mandible.

Fig. 171 is an *x*-ray photograph from the jaw of a child aged nine years. It shows a retained deciduous second molar at the bottom of the jaw, surrounded by an ovoid clear area. This patient had a swell-

ing of the left side of the lower jaw for about two years, which gradually increased in size, causing considerable deformity.

Examination showed a smooth swelling about the size of a hen's egg, with thin, parchment-like walls, covered only by the mucous membrane. A diagnosis of dentigerous cyst was made. At operation through the mouth the thin shell of bone was found to contain no fluid, but a resilient mass of pinkish-white tissue surrounded by a sac of darker color. The contents including the soft tissue, the dental sac, and the tooth shown in the picture were removed and the cavity lightly packed with gauze. The patient made an uneventful recovery.

Pathological Report.—Characteristics of Tumor.—Size 3 x 3 x 3 cur.

Macroscopic.—Pinkish-white mass of resilient tissue with villous or papillary surface, enclosed in sac of denser material, (1) premolar and (2) temporary molar embedded in wall.

Microscopic.—Fibrocellular stroma, which in places shows small spaces lined with columnar epithelial cells. These cells are much elongated in places, and the nuclei appear to be situated away from the connective-tissue stroma, as in the ameloblasts. Here and there, instead of a cavity lined by the epithelial cells, the space appears to be filled with stellate reticulum.

CHAPTER VII.

THE NASAL CAVITY AND ITS ACCESSORY CELLS AND SINUSES.

Descriptive Anatomy.—The nasal cavities—the internal nose—consist of two chambers situated on each side of the median line of the face, extending downward from the under surface of the anterior portion of the brain-case superiorly, to the upper surface of the bones forming the hard palate inferiorly, and from the facial border of the external aperture of the nose anteriorly to the free border of the external pterygoid plate posteriorly. They are lined with mucoperiosteum, covered with ciliated epithelium; and the membrane is continuous with the lining of the several sinuses, cells, and passageways of this region. On the upper, lateral, and posterior borders of the nasal cavity there are various mucosa-lined sinuses, cells, and canals, all communicating with the cavity, the excess of fluids secreted by them passing into the nose. The nasolacrimal ducts conveying the excess of fluids from the anterior surface of the eyes, the auditory tubes communicating with the middle ear, and the maxillary sinus, the frontal sinus, the sphenoidal sinus, the ethmoidal cells, ethmosphenoidal cells, and the cells belonging to the orbital process of the palate bone, have their outlets in the nasal cavity. The cavities are separated by a thin partition of bone and cartilage, the nasal septum; it opens on the anterior surface by the anterior nares. The two principal functions of the nose of man are concerned with respiration and with the special sense of olfaction.

The middle meatus of the nasal cavity forms the principle nasal passageway for the air into the respiratory tract, also for the expired air leaving the lungs. The upper portion of that part of the cavity formed by the ethmoid bone contains the beginning of the olfactory organs. As it is necessary to their function that these parts be kept moist, there are numerous pockets in and about them, the lining

membrane of which secretes fluids. These fluids pass over the shed-like projections of the concha bones into the nose, supplying the necessary moisture.

Figs. 196 and 197 are good examples of the nasal cavities showing bilateral symmetry. For descriptive convenience it may be divided into roof, floor, and outer and inner walls, the last named being formed by the medial wall or nasal septum.

The roof of the nasal cavity is long, narrow, and irregular in form. It is divided into anterior, middle, and posterior sections.

The anterior portion is formed by the under surface of the nasal bones and the nasal spine of the frontal bone. It is concave from side to side, and extends inward and upward to the ethmoid bone, at an angle of about forty-five degrees.

The middle portion is narrow, nearly horizontal in direction, and is composed of the under surface of the cribriform plate of the ethmoid bone, through the openings of which the filaments of the olfactory nerves pass between the nasal cavities and the brain. Beside the numerous openings there are slit-like foramina, which give passage to the nasal nerves and vessels. The cribriform plate, on account of its thinness, its sieve-like construction, and the presence of the slit-like openings, affords but a slight partition between the nasal cavity and the anterior portion of the brain-case.

The posterior portion of the roof of the nose is the longest of the three parts, and extends from the posterior extremity of the cribriform plate obliquely downward and backward to the free margin of the internal pterygoid plate. It is composed of the body of the sphenoid bone and the alæ of the vomer.

The floor of the nasal cavity extends from the external opening anteriorly to the pharyngeal space posteriorly. It is smooth, and concave from side to side. The bony structure is composed, anteriorly of the intermaxilla, medially of the palate processes of the maxillæ, and posteriorly of the horizontal plate of the palate bone. The naris are made up of cartilage lined with mucous membrane, and form the vestibule of the nose. In the normal nose, the floor joins this on the same plane and gradually slopes downward and backward (see Fig. 301).

Occasionally there is a depression immediately back of the union of the bone and cartilage. The floor often varies in its relative position to the other structures. It is seldom on the same level as the floor of the maxillary sinus; it may be on either a higher or a lower plane. Examples of these variations are seen in the sections shown in Figs. 261, 262, 263 and 264.

The nasal septum (medial wall) forms the inner walls of the nasal cavities. It consists of six bony structures, named in the order of their importance—viz., the vertical plate of the ethmoid, the vomer, the crests of the maxillæ and palate bones, the rostrum of the sphenoid, and the nasal spine of the frontal bone. These bones do not form the septum completely, but leave a triangular notch in the anterior portion, which is filled up with cartilage.

Septal Spurs.—In Figs. 195, 196 and 197 it will be seen that the nasal septum is nearly vertical, without a bend or a nodular process or "spur" upon it. It is commonly thought by rhinologists that a straight septum is unusual. This would seem to be an error, probably due to the fact that the great majority of the noses which they examine are abnormal. It is quite true that in many cases the septum is more or less deflected to one side or the other, assuming a central position only as it passes downward and nears its connection with the floor of the cavity. On the convex side of the curve in these cases a ridge or process is often found which is called a "spur," and which may extend quite over and come in contact with the external wall or the inferior concha (see Figs. 262, 263, 281, 292 and 293).

Nasal Meati.—The lateral wall is the most extended, irregular, and complicated portion of the nasal fossa. It varies, perhaps, more in its general formation than any other portion of the body of like size, and is correspondingly difficult to treat surgically. Several bones enter into its formation on each side—viz., the nasal, maxillary, lacrimal, ethmoid, inferior nasal concha and palate bones, the pterygoid process, and the body of the sphenoid bone. By the projection of the inferior nasal concha and processes of the ethmoid bone, the wall is divided into several almost horizontal compartments known as meati. The anatomical works generally name three meati—the

inferior, the middle, and the superior. Zuckerkandl, however, says that about $6\frac{7}{10}$ per cent. of the skulls examined by him have had four meati. The writer has found about 60 per cent., with four meati in the skulls of which he has made sections (see Figs. 173 and 285). In many cases there are five, and in one skull six were found.

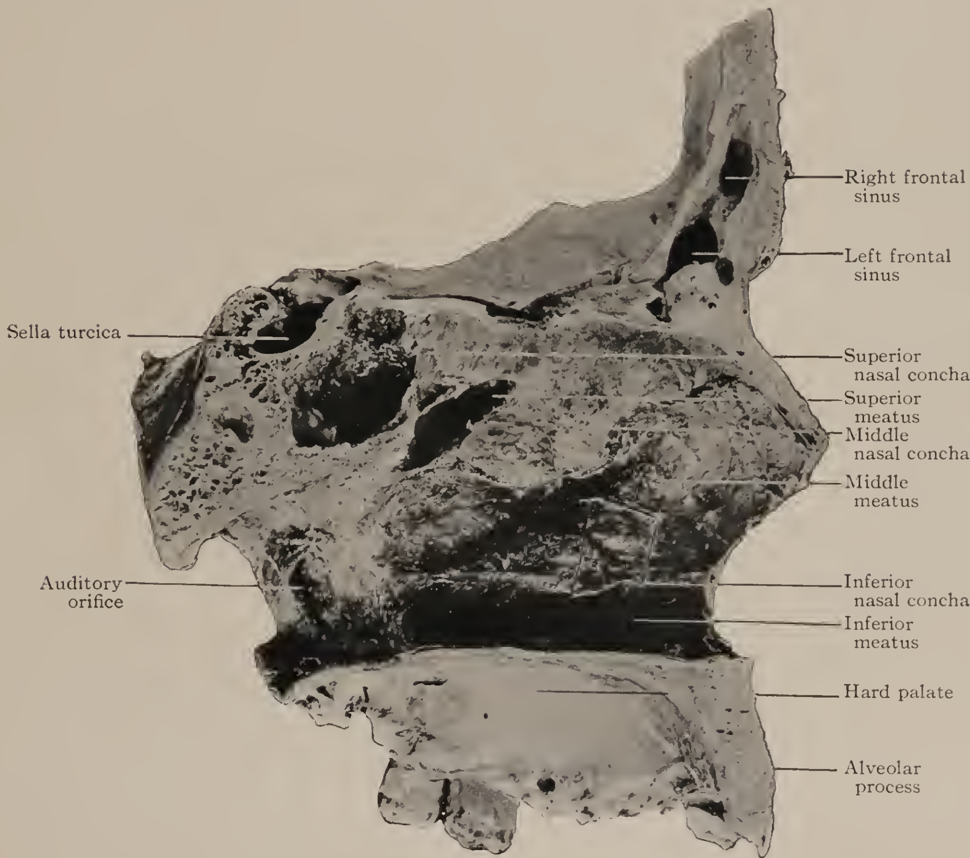
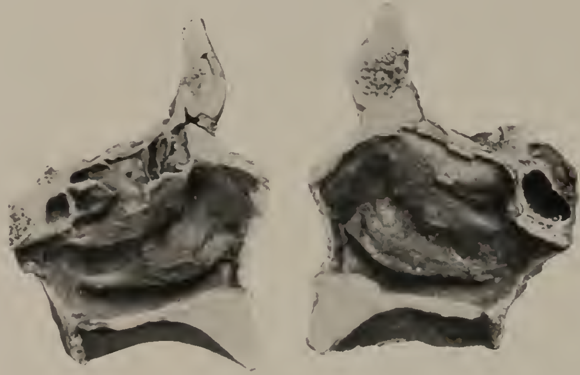


Fig. 172.—Lateral wall of a left nasal cavity.

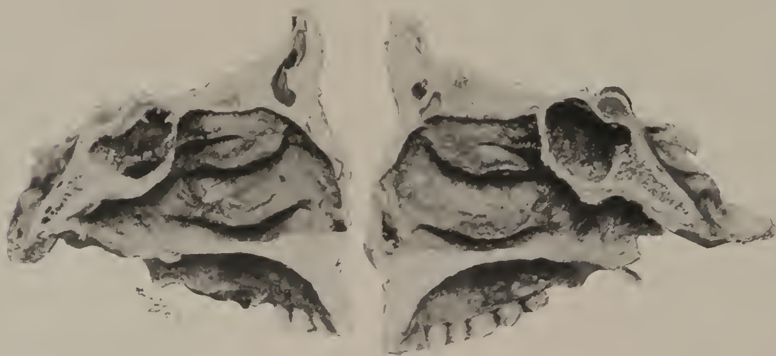
Figs. 172 and 173 give a general idea of the arrangement of the outer walls of the nasal cavity. The upper portion, or all of that which belongs to the ethmoid bone, is associated with olfaction. The ends of the nerves, usually called the terminals, have their origin over this region; they also are distributed over the upper portion of

the septum and the roof of the nose. The fibers converge as they pass upward to form the filaments, and then through the various foramina in the cribriform plate of the ethmoid bone enter the olfactory bulb. The various meati have communications with the maxillary sinus and other air spaces which are formed in the bones of this region.



A *B*

Fig. 173.—Lateral walls of the nasal cavities, each showing four meati.



A *B*

Fig. 174.—Lateral walls of right and left nasal cavities, with large sphenoidal sinuses, *B*, having four meati.

Fig. 174 gives a view of the lateral walls of the nasal cavity of the same skull as Figs. 215 and 216. The sphenoidal sinus extends laterally until it forms the cavity posterior to the maxillary sinus. In Figs. 217 and 218 it will be observed that the large sphenoidal sinus extends

well forward toward the frontal bone and backward toward the basilar process of the occipital bone.

Inferior Meatus.—The inferior meatus is situated between the inferior nasal concha and the floor of the nose. It is much longer than the others.

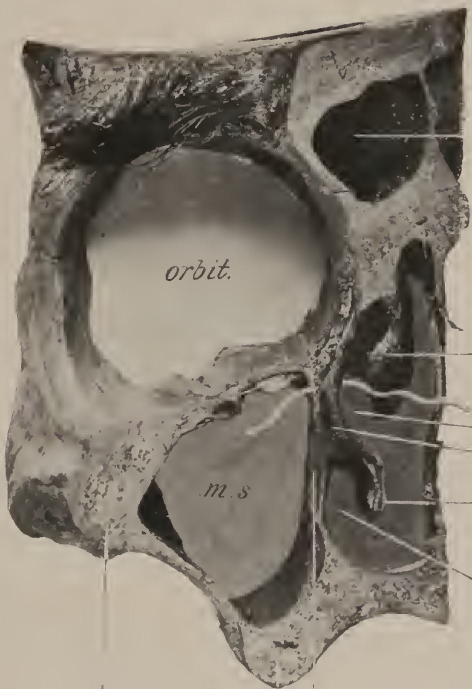


FIG. 175.—Anterior view of a vertical transverse section of the right side of face.

Nasolacrimal Canals.—The nasolacrimal canals, which are for the accommodation of the nasolacrimal ducts, have their origin in the inner anterior lower angle of the orbits. The superior orifices commence between the nasal processes of the maxillæ and the lachrimal bone. From this point the canals extend down and terminate in the upper portion of the inferior meatus of the nose (see Figs. 175, 176, 177, 178 and 179). The direction of their descent varies considerably in different subjects, and even in the same subject. They usually pass backward,

and when the maxillary sinus is large and the nasal cavity narrow, the direction may be inward; where the maxillary sinus is small and the nasal cavity wide, the direction is likely to be outward. In exceptional cases it is slightly curved. The duct may have a valve composed of mucous membrane at its lower extremity.

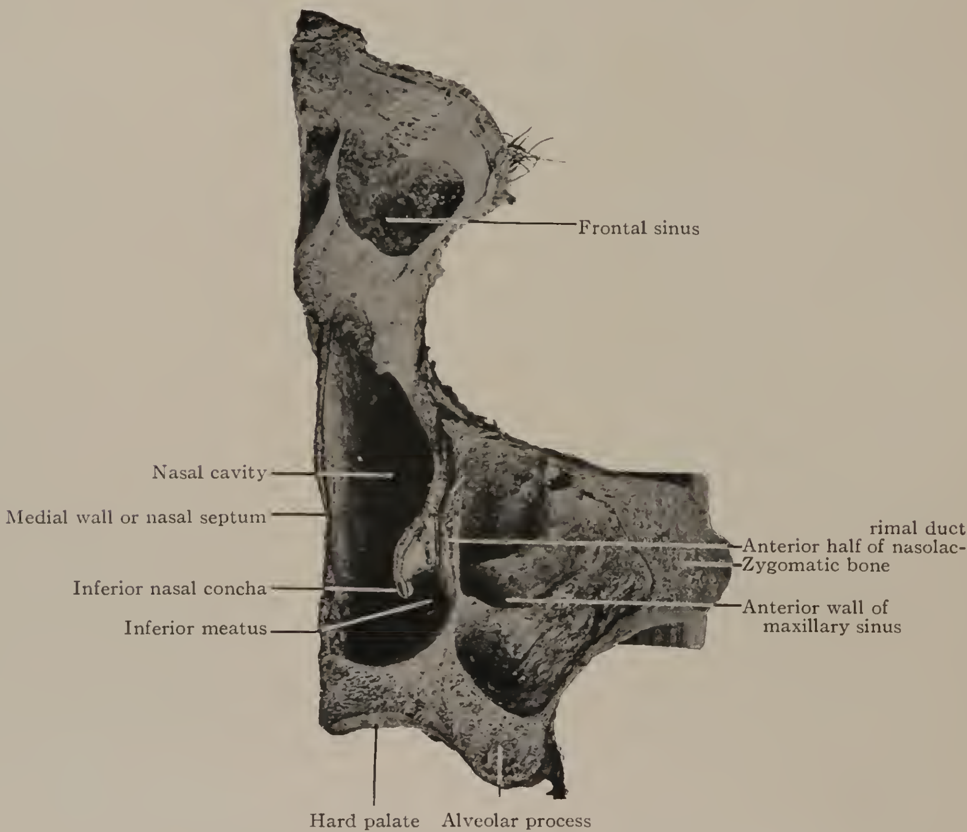


FIG. 176.—Posterior view of a vertical section cut from the front of Fig. 175.

Fig. 175 affords an anterior view of a section cut vertically or longitudinally through the nasolacrimal duct, showing its posterior portion as it passes from the orbit downward within the wall, separating the nasal cavity from the maxillary sinus, the duct terminating in the upper portion of the inferior meatus. On the upper right corner

is the frontal sinus. To the left of this is the orbit. In the centre of the wall between the orbit and the maxillary sinus will be seen the infra-orbital canal, and below it the maxillary sinus, which in this case is very large. In the upper portion of the nasal cavity is seen the middle nasal concha, below which a cord has been passed from the middle meatus through the ostium maxillare into the maxillary sinus.

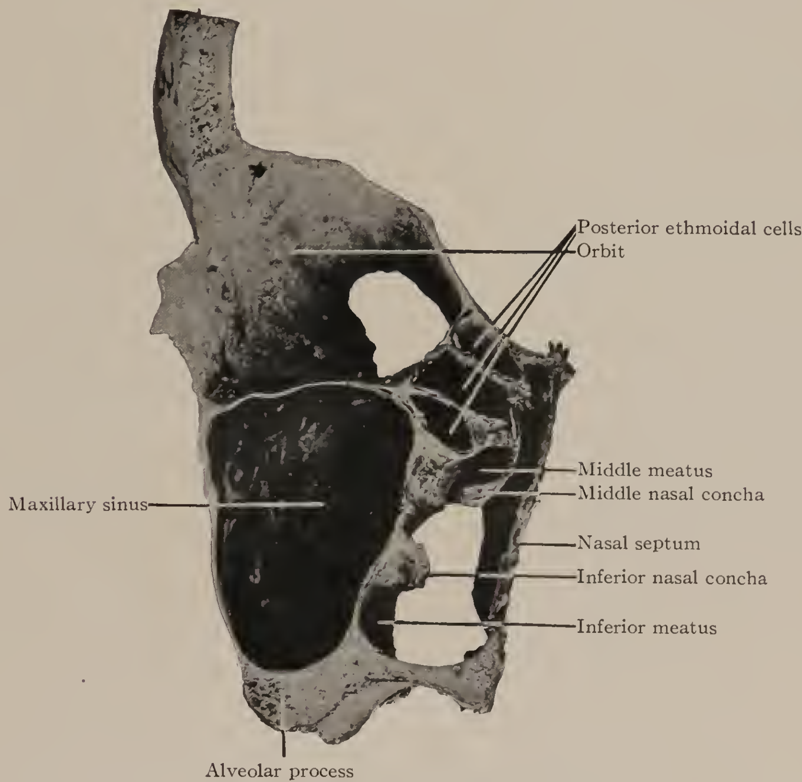


Fig. 177.—Anterior view of vertical section cut posterior to that shown in Fig. 176.

Fig. 176 is from a vertical section, cut transversely just within the infra-orbital ridge. In the upper portion is the anterior wall of the frontal sinus, on the left side is the middle wall, and to the right of this is the nasal cavity. The anterior half of the nasolacrimal duct, shown in the previous illustration, will be seen to commence at the inner angle of the orbit and terminate at the inferior meatus.

Fig. 177 is from a section near the posterior wall of the maxillary sinus and the orbits, from the same subject as Figs. 175 and 176. It will be noticed that the wall of the maxillary sinus is very thin. At the upper right corner are seen the posterior ethmoidal cells, below which is the nasal cavity.

Fig. 178 is from a section showing the greater portion of the upper jaw. The upper boundary is on a level with the middle of the orbits. Two sounds passed down into the nasolacrimal ducts indicate that

FIG. 178.—Section showing the greater portion of the upper jaw. *S*, *S*, sounds passed down the nasolacrimal ducts, showing that they do not pass at the same angle. The illustration also shows an impacted canine tooth. (For description see page 177.)

the ducts pass outwardly as they descend into the upper part of the inferior meatus. It will be observed that the right duct has a greater outward deflection than the left.

The horizontal line above the roots of the teeth and below the zygoma makes a division of the section just above the floor of the nasal cavity. The under surface of the upper portion is shown in Fig. 179, which affords a view of the surface of the inferior concha from below, with the lower orifices of the nasolacrimal duct. It also shows the lower edges of the middle and superior concha, and the

roofs of the antra. Attached to the roof of the right maxillary sinus are two abnormal bony growths generally known as osteophytes.

The middle meatus is situated between the lower portion of the concha of the ethmoid bone and the inferior concha, and forms two-thirds of the posterior portion of the outer wall of the nasal cavity. This is the most important meatus, as it is the principle nasal

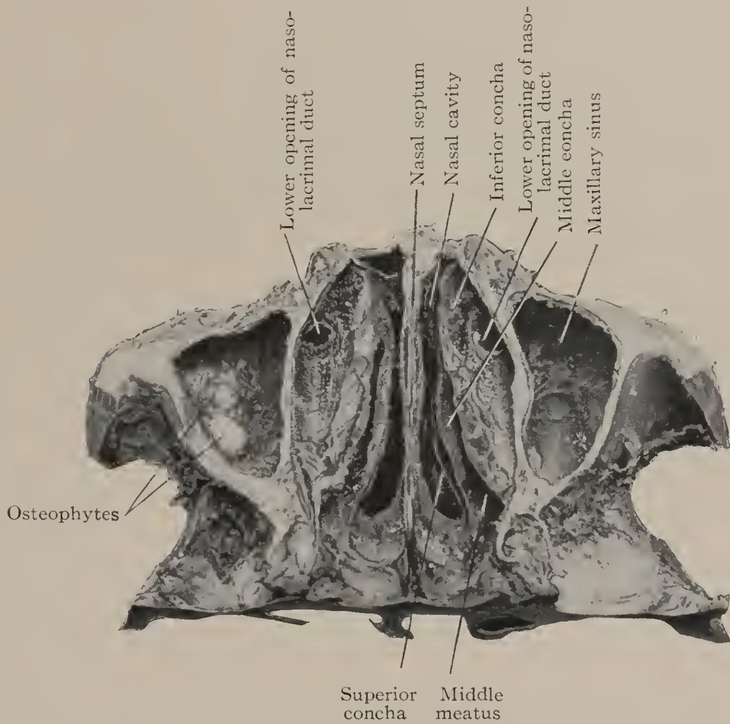


FIG. 179.—Horizontal section, showing the under surfaces of the inferior concha and the outlet of the nasolacrimal duct.

passageway of respiration, and is subject to more variations in its anatomy, physiology, and pathology than are all the others. It has anatomical communications with the frontal and maxillary sinuses, and with the anterior and middle ethmoidal cells. In order to study this meatus and its relations, it is necessary to make a number of sections of the parts with all the tissues in place. By removing the middle concha, the structure of the parts is brought into view.

Fig. 180 shows the outer wall of the nasal cavity with the internal wall of the middle concha of the ethmoid bone cut loose and turned up, affording a good idea of the normal anatomy of this region. The frontal sinuses are exposed. In the illustration the right frontal sinus

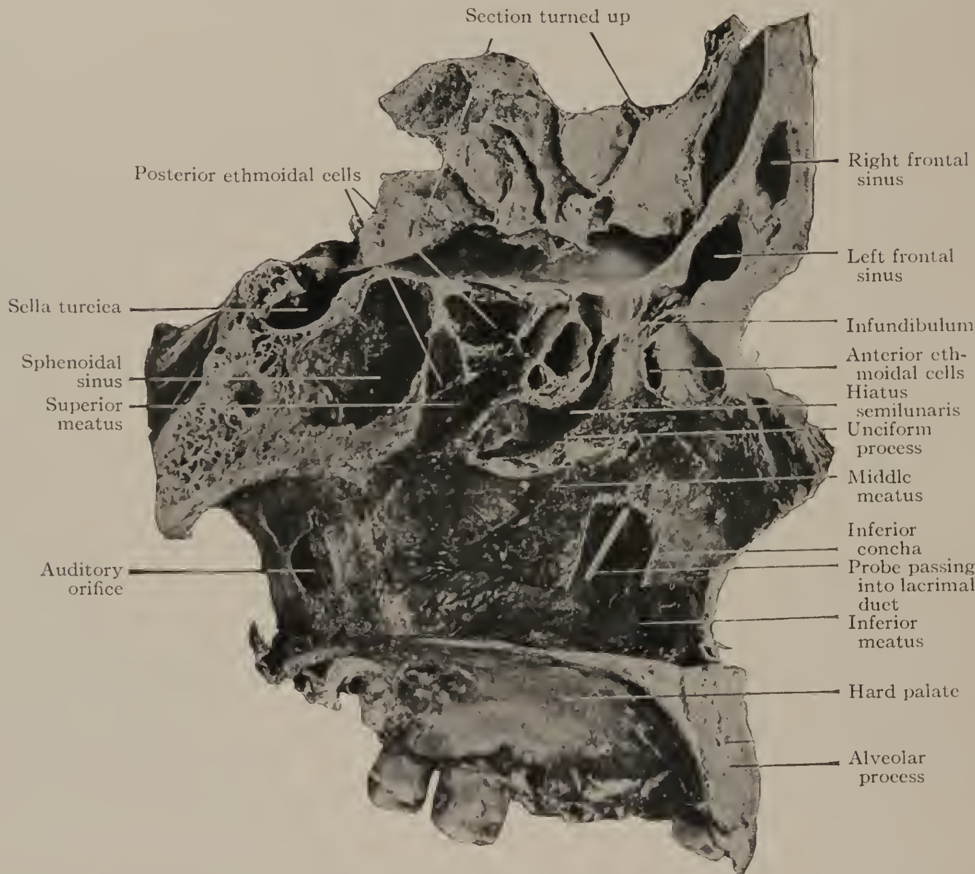


FIG. 180.—An anteroposterior section within the nasal cavity, with the middle concha and portion of the cell walls turned up.

extends over the left side of the medial line. The open space immediately below this is the left frontal sinus. The partition between these sinuses in some places is thin. The lower portion of the left frontal sinus is funnel-shaped. This opens into a passage leading into the

middle meatus, the funnel-shaped portion and the passage being commonly called the infundibulum. This illustration also gives a good idea of the nasal surface of the partition between the maxillary sinus and the great extent of the mucous-lined sinuses and cells that are so directly related with it. When these pneumatic spaces become diseased, it is almost impossible to keep the sinuses in hygienic condition, and when the infection reaches them, they are much more difficult to treat and drain than when the disturbance comes from the teeth or alveolar process.

Hiatus Semilunaris.—The infundibulum is often included in the part which has been named by Zuckerkandl the hiatus semilunaris, and which extends from the frontal sinus to and through the middle meatus in the form of a semicircular groove or cleft along the outer wall of the meatus. It extends downward and backward in a curved direction, being horizontal in its posterior portion, and terminates a little behind the centre of the nasal cavity. At its commencement it is narrow, but it widens as it passes downward and backward, its widest part being at the bottom and near the opening between the maxillary sinus and the nasal cavity (ostium maxillare). Besides the opening of the frontal sinus into the hiatus semilunaris, there are openings from the anterior and middle ethmoidal cells, and from the maxillary sinus. Its inner boundary is falciform in shape, and is composed of the uncinate process of the ethmoid bone with membranous tissue, forming a shield or guard to the opening of the maxillary sinus, to prevent foreign substance from passing into it.

A "sound" cannot be passed from the nasal cavity through the ostium maxillare into the maxillary sinus in a normal living person.

The **superior meatus** is shallow, and is shorter than the inferior or middle meatus. It is situated between the superior and inferior concha masses of the ethmoid bone, and in the articulated skull between the superior and middle concha. The cell situated in the orbital process of the palate bone, the posterior ethmoidal cells, and the sphenoidal sinus all have their openings into this meatus when there are but three meati, but when there are four, the posterior ethmoidal cells and the sphenoidal sinus have their openings into the fourth or superior

meatus. If there are five meati the sphenoidal sinus usually opens into the fifth. In other words, this sinus has a tendency to open into the highest meatus.

The **fourth or superior meatus** of Zuckerkandl is formed by an infolding of a portion of the concha similar to that of the third or superior meatus, though smaller in extent. When the fourth meatus exists, the fluids of the posterior ethmoidal cells and those from the sphenoidal sinus pass through it to reach the nasal cavity.

The **occasional fifth meatus** is formed similarly to the third and fourth meati by an infolding of the upper portion of the ethmoid mass. In such cases the fluids from the sphenoidal sinus pass through it instead of into the fourth.

PATHOLOGICAL CONDITION OF THE NASAL CAVITY.

Pathological Conditions of the Bulla Ethmoidalis.—Through *pathological increase in the size of the bulla ethmoidalis*, disturbances may be caused in the anterior and superior portion of the nasal cavity, in the frontal sinus, and maxillary sinus, for by its enlargement toward the median line it presses toward and against the septum of the nose, closing the space of the nasal cavity. If this enlargement is downward it presses more upon the unciform process and into the hiatus semilunaris, closing it and preventing the passage of fluids from the frontal sinuses and the anterior ethmoidal cells into the posterior portion of the middle meatus, and forcing them to enter the maxillary sinus. Through general inflammation of the parts there may result an excess of fluids which cannot find exit. This would interfere with the vitality of the teeth through pressure upon the nerves and vessels passing through the maxillary sinus. It would cause a feeling of fulness of all the anterior cells, as well as the frontal sinus, and might even set up disturbance in the anterior portion of the brain-case.

A view of the nasal septum as seen from the left nasal cavity is shown in Fig. 181. An opening in the septum exposes to view the bulla ethmoidalis and the ethmoidal cells. This opening resulted from resorption caused by pressure due to the deflection of the septum and

the enlargement of the bulla downward near the unciform process. We have here illustrated an example showing how enlargement of this structure may be an important factor in causing various diseases of this region, including those of the maxillary and frontal sinuses.

Fig. 182 gives a view of the same subject as Fig. 181, from the same direction, but with the septum removed, exposing the inner surface of the outer wall of the right nasal cavity. Of the two openings into the maxillary sinus as seen in this picture, the anterior one is normal, the posterior is pathological. This abnormal opening and the loss of

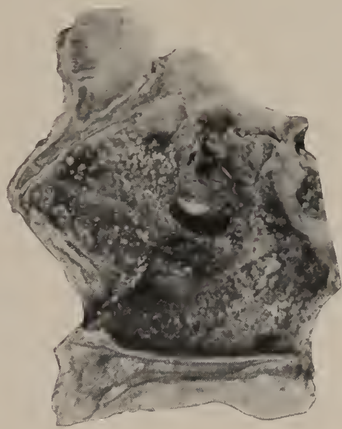


Fig. 181

Fig. 182

Fig. 181.—The left side of the medial wall, showing a pathological opening opposite the bulla ethmoidalis.

Fig. 182.—Same specimen with the septum removed, showing abnormal opening into the maxillary sinus.

the greater portion of the middle concha were caused by resorption due to the pressure of the bulla ethmoidalis before referred to.

The effect of blocking up the hiatus semilunaris, causing the secondary or associated openings between the sinus and the nasal cavities, is also shown in Fig. 185.

Figs. 183 and 184 show two pictures from the left side of the same skull shown in Figs. 181 and 182. In Fig. 184 the middle concha is in position. The abnormal opening into the nasal cavity, seen near the centre of the picture, was probably the result of the closure of the

hiatus semilunaris, shown in Fig. 183. In this the middle and a portion of the superior concha are cut loose and turned upward, to expose the bulla ethmoidalis extending downward and closing the hiatus. This

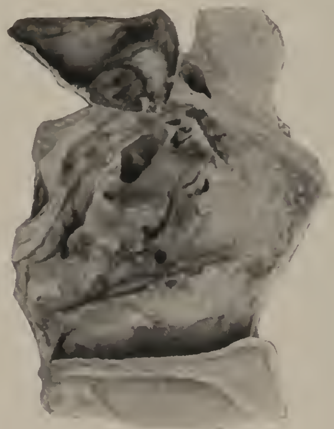


Fig. 183

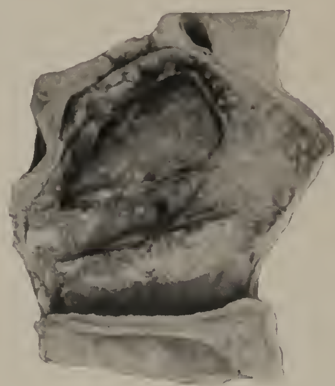


Fig. 184

Figs. 183 and 184.—Two pictures of the left nasal cavity from the same subject as Figs. 181 and 182, showing a pathological opening into the maxillary sinus in Fig. 184. Fig. 183, the same specimen as Fig. 184 with a portion of the middle and superior conchas cut loose and turned up.

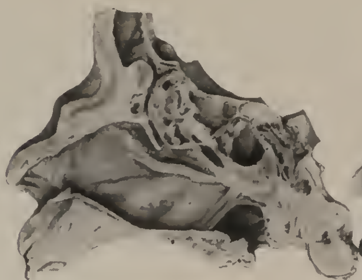


Fig. 185

Fig. 186

Figs. 185 and 186.—Anteroposterior sections, Fig. 185 through the nasal cavity, Fig. 186 through the maxillary sinus. The former shows a divided bulla ethmoidalis, the latter shows two ostia maxillaria, one being pathological.

closure would compel the fluids from the frontal sinus and the anterior and middle ethmoidal cells to pass into the maxillary sinus.

Figs. 185 and 186 show two anteroposterior sections from another skull in which the bulla ethmoidalis has become enlarged. Fig. 186

has the outer wall of the maxillary sinus removed, showing the inner wall with two outlets at its upper margin. The anterior opening is the normal ostium maxillare. The posterior one is pathological and similar to those shown in Figs. 181, 182, 183 and 184, but in this case the opening is nearer the roof of the sinus. Fig. 185 is cut from the inner side of Fig 186.

Figs. 187 and 188 illustrate the same sections as Figs. 185 and 186 with Fig. 188 turned round to the left side of the other. The illustration affords a view of the nasal cavity divided through the hiatus semilunaris, the bulla ethmoidalis, and the posterior ethmoidal cells. Fig. 188 shows the lateral wall of the nasal cavity with a greater

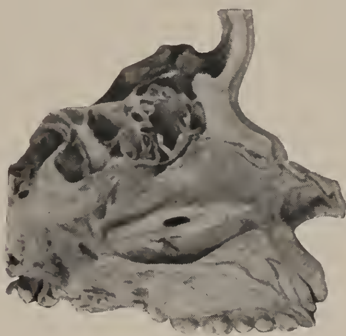


Fig. 187

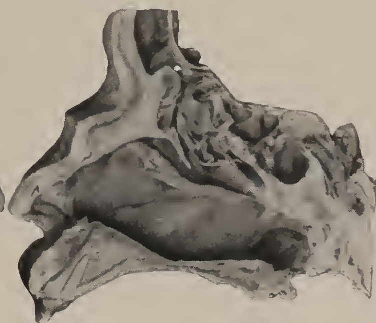


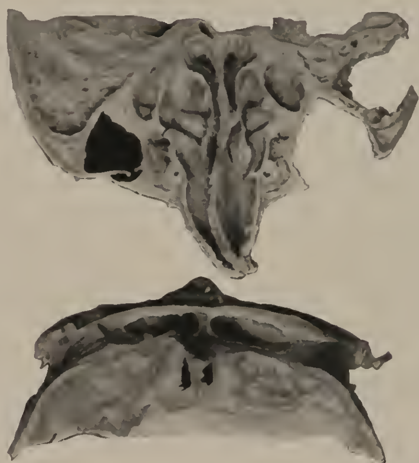
Fig. 188

Figs. 187 and 188.—Anteroposterior sections, cut apart through the frontal sinus, the hiatus semilunaris, the bulla ethmoidalis, and the posterior ethmoidal cells.

portion of the conchæ removed. Fig. 187 shows the septum of the nose. The two together give a very clear idea of the character of the hiatus semilunaris and the bulla ethmoidalis. In this case the bulla is very large and extends downward and forward, closing the hiatus. The illustration is taken from a dried specimen, showing an incomplete closure, which in the recent state must have been complete. This would have caused the fluids from the frontal sinus and the ethmoidal cells anterior to the closure to be directed into the maxillary sinus, as the ostium maxillare is also anterior to the bulla ethmoidalis. The maxillary sinus would become engorged with these fluids, which would naturally make their way through the walls in the direction of the

least resistance—in this case at the abnormal opening shown in Fig. 186. These sections also illustrate a condition sometimes met with, when the hard palate is unusually flat. In such cases the floor of the nose, instead of being horizontal, is depressed about the middle, giving a concavity which affords a lodgment for inspissated mucus. The same condition may also occur in the floor of the nose, when the inferior meatus is occluded, as shown in Fig. 262, and is also found in other spaces in and about the nasal cavity. Collections

A



B

FIG. 189.—*A* shows the roof of the nasal cavity and the maxillary sinus, *B* shows the floor of the anterior fossa of the brain-case and part of the frontal sinuses, to one of which there is no foramen of exit.

of this character often produce irritation of the mucous membrane interfering with the nourishment of the bone beneath, and at times causing a necrotic condition.

Occlusion of the Outlets of the Frontal Sinus.—In Fig. 189, *B* shows a horizontal section through the anterior fossæ of the brain-case and through the frontal sinuses, from one of which there has been no foramen of exit, an example of unilateral occlusion. A view of the roofs of the maxillary sinuses and of the nasal cavity is given in *A*.

The section shown in Fig. 190 is made from the same subject

as Fig. 189, one inch below *B*. It exhibits the downward excavation which has occurred in the occluded sinus. In the lower surface, *A*, is shown the excavation extending in the direction of the nasal spine. There are marked irregularities in the ethmoidal cells of the two sides.

Fig. 191 also illustrates unilateral occlusion. This section displays the floor of the brain-case, showing a perforation at the point indicated by the thread passing through it. It is reasonable to suppose that the retained fluids have burrowed through the cribriform plate, causing

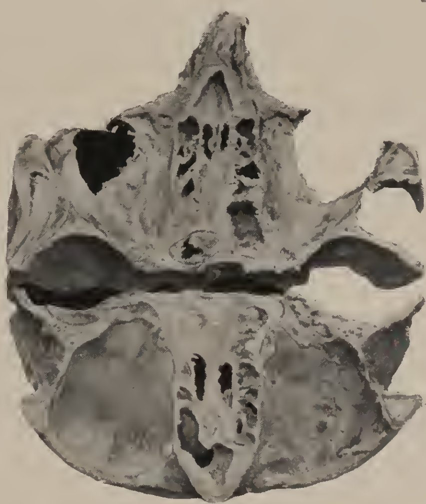


FIG. 190.—Horizontal sections in same subject as Fig. 189, showing surfaces cut through the middle of the orbits and the upper part of the nasal cavity.

the perforation. The crista galli in the specimen, although not clearly shown in the picture, is bent downward until almost flat by what has evidently been a cyst or tumor within the brain-case in this region. Unfortunately, the writer was unable to obtain antemortem or clear postmortem notes of these two cases. It might be supposed, however, that the patients presented cerebral symptoms. In confirmation of this idea, there was evidence in the condition of the skulls that there had been a postmortem examination of them.

Fig. 192 is from the same specimen as Fig. 191. It shows the effects of the encroachment of the inflammatory and necrotic condition upon the internal wall of the orbit.

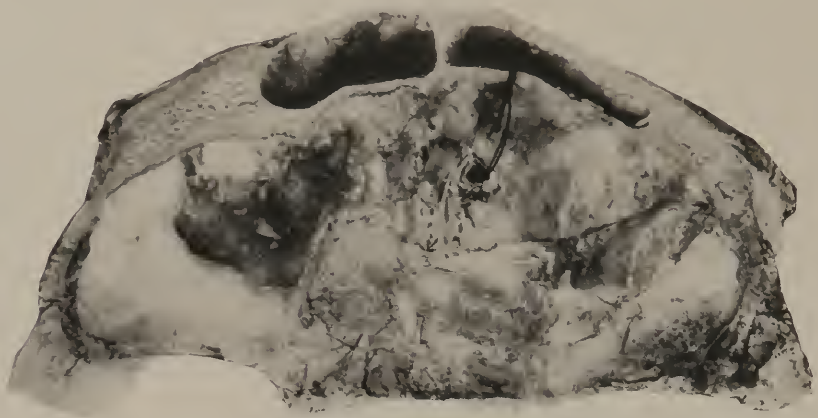


Fig. 191.—Horizontal section, showing the floor of the anterior fossa of the brain-case and part of the frontal sinuses. The right sinus had no outlet into the hiatus semilunaris, but had an outlet into the anterior fossa of the brain-case.

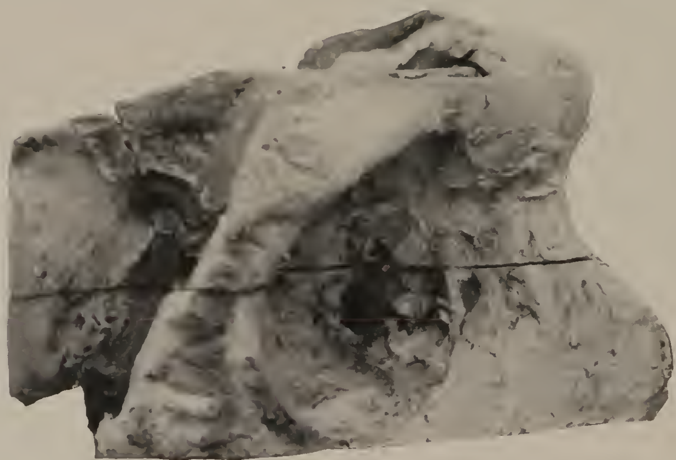


Fig. 192.—From same subject as Fig. 191. View showing diseased condition of the inner wall of the orbit.

Fig. 193, from the same specimen, shows a horizontal section made through the ethmoidal cells, the nasal fossæ, etc., along the line indicated in Fig. 192. The two faces of the specimen show clearly the

broken-down condition produced in the track of the disease. The abnormal arrangement of the cells becomes especially apparent when compared with the typical arrangement shown in Figs. 257 and 258.

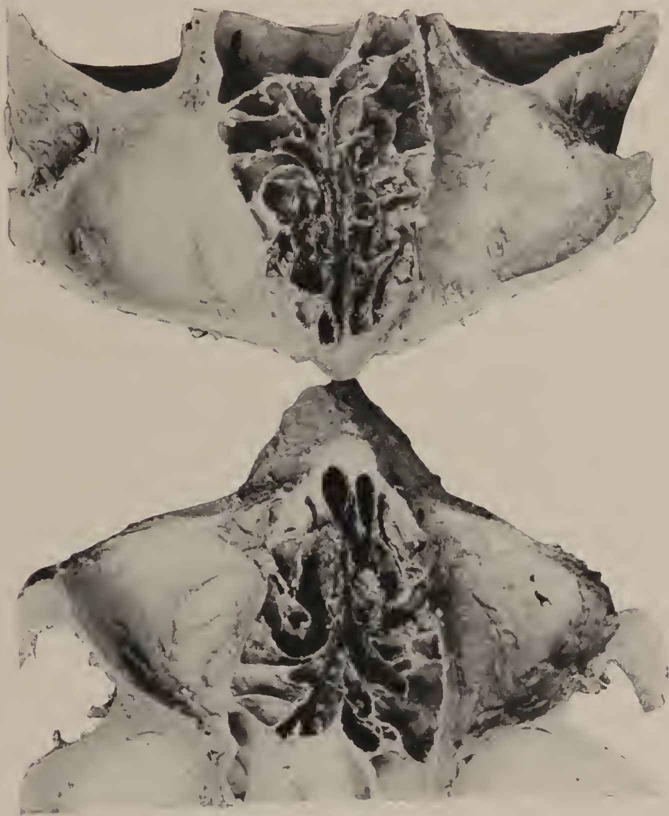


Fig. 193.—From the same subject as Figs. 191 and 192. Horizontal division through the orbits and ethmoidal cells, showing the diseased condition of these cells.

Obstruction of Fluids.—There is a fundamental law of surgery that, wherever an obstruction of any of the passages within the body exists, it should be removed, and if possible the course of fluids be reëstablished in their normal channels or conduits. If the hiatus semilunaris, which is the outlet of the fluids of the frontal sinus, becomes closed in any portion, or at the inlets, by bony or other growths, it is

good and proper surgery to remove this obstruction. If the fluids from the various sinuses and cells are allowed to accumulate in the maxillary sinus without an opportunity to escape back into the nasal cavity, through a pathological or surgical opening, the teeth and their alveolar processes are liable to become involved.

The mouth should by all means be kept free from foul discharge, and such proper surgical procedure instituted as will restore the natural outlets without infecting the oral cavity, as by the action of mastication, septic fluids become mixed with the food and are thus distributed through the alimentary canal to infect the entire system.

CHAPTER VIII.

THE MAXILLARY SINUS.

THE maxillary sinus (*antrum of Highmore*) is situated in the body of the maxillæ, and is the largest air space associated with the nasal cavity. It varies in shape, size, and in the thickness of its walls, according to age, race, and the presence or absence of teeth and tooth-germs

FIG. 194.—A horizontal section of face cut just above the floor of the nasal cavity.

within the jaw. It is lined with mucoperiosteum surmounted by ciliated epithelium. The typical sinus is pyramidal in shape, the apex being toward the zyomatic bone—into which it may extend (see Fig. 271)—and the base toward the nasal cavity. Its size and form vary in different

subjects, and even in the two sides of the same subject (see Figs. 263, 264, 265 and 266). In rare cases, it is lacking on one or both sides (see Fig. 194).

Fig. 194 shows two horizontal sections. The lower one giving a good view of a very wide floor of the nasal cavity. The upper one showing the walls of the nasal cavity, the concha bones and the septum.

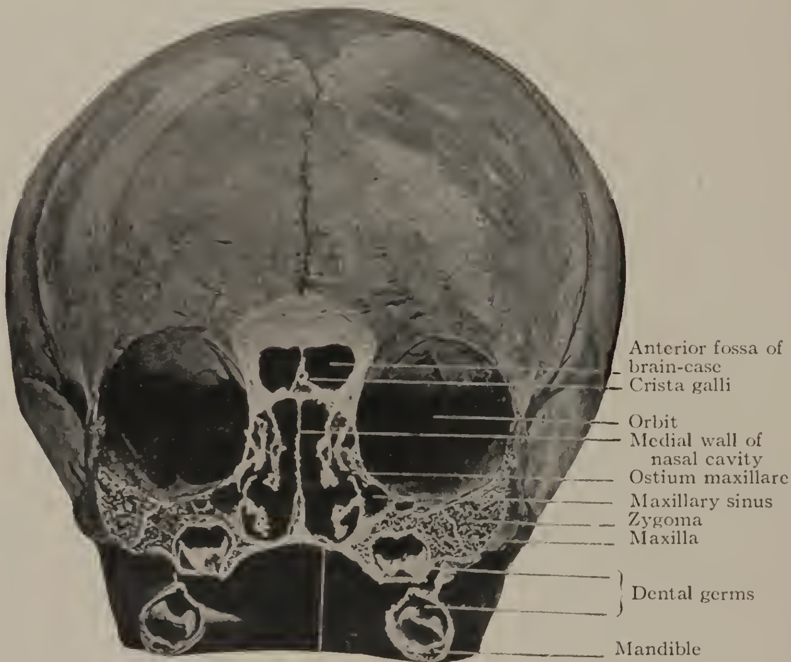


FIG. 195.—Skull of a fully developed embryo cut vertically through the first deciduous premolars.

On the right side there is no maxillary sinus and on the left the sinus is very small, thus accounting for a wide nasal cavity.

Fig. 195 is a view of the skull of a fully developed embryo.[1] It is a transverse section cut vertically just within the floor of the orbit. In the upper portion are seen two openings into the brain-case with the crista galli and falx cerebri between them, below which is the nasal cavity with its septum. Projecting from the outer wall of the cavity

[1] From the collection of Professor Thomas C. Stellwagen.

are the middle and inferior concha. In the middle meatus may be seen the unciform process passing upward and a little inward from the base of the inferior concha. At the outer side of this is the passageway known as the hiatus semilunaris, into which the ostium maxillare passes from the maxillary sinus, which is very small at this period of embryonic life.

Development.—The development of the sinus begins about the fourth month of intra-uterine life by an invagination of the lining membrane of the nose from the hiatus semilunaris into the body of the maxilla. From the time of the invagination until the eruption of the permanent teeth, the greater portion of the maxilla is occupied by the dental organs (see Fig. 137). As the invagination progresses, the cancellated portion of the bone undergoes resorption. This resorption of the internal portion of the maxilla is continued in a variable degree throughout life, until in old age the walls usually become exceedingly thin, as shown in Fig. 205. In some cases the decalcification and resorption are carried to such an extent that the entire bone is thinned, and an ordinary lancet blade can be easily passed through the wall into the sinus, or the entire substance of the bone may be resorbed in places, leaving nothing but the mucoperiosteum at these points. As this process goes on, the roots of the premolars and molars within the walls are approached, until in many places the points of the roots are covered only by a thin lamina of bone (see Figs. 202 and 203). Even this, in rare cases, may be lost, leaving only the mucoperiosteum as a root-covering.

At first the sinus has a spheroidal shape, but it eventually approaches the pyramidal form. Its walls are five in number, the inferior or floor, the anterior or facial, the posterior or zygomatic, the superior or roof, and the proximal or nasal.

Fig. 196 is an excellent illustration of a transverse bilateral section cut vertically through the anterior portion of the orbit, the maxillary sinus, and the first molar of each jaw, dividing the eye just in front of the crystalline lens. In the upper portions of the nasal cavities are seen the middle ethmoid cells. At about the centre of the floor of the orbit and the roof of the sinus, which is very thin in this case, will

be found the infraorbital canal as commonly described, and below, the nearly pyramidal cavity of the maxillary sinus, with a partial septum crossing transversely from the inner to the outer wall.

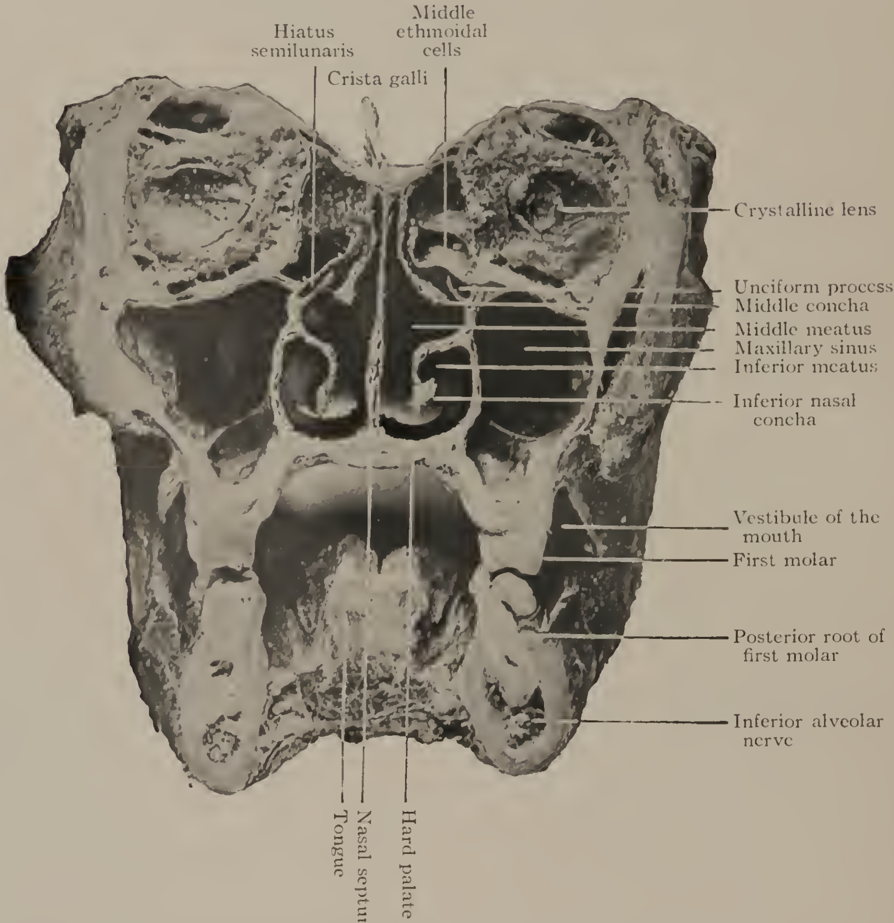


FIG. 196.—Anterior view of a vertical transverse section of the head, showing the relations of the jaws, and indicating the positions of the conchæ, antra, etc.

In the lower angle of the left sinus can be seen the anterior buccal root of the second molar, while on the inner wall is a portion of the palatal root of the first molar. The palatal root of the right first molar is easily seen passing well up in the inner wall of the sinus.

The central portions afford excellent views of transverse sections of the nasal cavity. The septum in the centre is unusually straight. Above the septum is the crista galli, to which the falx cerebri is attached anteriorly. On each side of the septum, at the upper attachment, is the roof of the nasal cavity, below at a little distance are the middle conchæ, and, on the outer wall, are the inferior concha. The superior conchæ cannot be seen in a section cut in this region, as they are situated farther back in the skull.

FIG. 197.—Posterior view of vertical transverse section of the head from the same skull as Fig. 196, showing the ostium maxillare, which is indicated on each side by a cord passed through it.

Fig. 197 represents the anterior portion of the same skull shown in Fig. 196. At the anterior superior angle of the maxillary sinus is a cord marking the passage (ostium maxillare) from the sinus into the hiatus semilunaris. In the floor of the maxillary sinus will be seen the septum referred to in the description of Fig. 196. On the left side will be observed the palatal and anterior buccal roots of the first molar in the outer and inner walls of the sinus. The positions of these roots, as shown here and in Fig. 196, are very interesting from a dental

standpoint. The extraction of teeth having roots in such positions, if not carefully done, might carry away parts of the floor of the sinus (see Figs. 231, 232 and 233), or in case of breakage in extracting, the roots could easily be forced into the sinus by injudicious use of the forceps. Also, by using too much force in placing artificial crowns, the floor might be fractured.

Fig. 198.—*X*-ray of a dried skull.

In the majority of the skulls belonging to the white races, roots of the molar teeth pass up into the walls of the maxillary sinus, being covered at the point where they approach the surface by a thin conical portion of bone.

Fig. 198 is from a radiograph of the anterior portion of the face, showing two large frontal sinuses. Two wires may be seen passing

downward through the ostium frontalis into the hiatus semilunaris, and then into the maxillary sinus, by the ostium maxillare. The infra-orbital sinus and the inferior and middle conchæ are seen, also two large cells between the plates of the latter.

When the maxillary sinus is large early in life, and extends downward into the region of the roots of the teeth, it prevents their normal development in shape and position, the roots grow curved and in the case of molars, are compressed (see Figs. 202 and 203). After early middle life, as the dentine forms, the pulp canals become more or less narrowed until the nerves are impinged upon, causing pain (neuralgia).

Fig. 199 is an *x*-ray picture of a large maxillary sinus, showing that it has apparently extended downward between the roots of the second premolar and the first molar; from the shape and position of the roots, especially of the first and second molar teeth, it is evident that the sinus was over size before these teeth were developed. In this particular case the patient suffered from severe neuralgia of the upper jaw. The *x*-ray showed the condition, and after removal of the first molar the pain subsided.

Fig. 200 shows a section similar in character to Figs. 196 and 197, but from a negro skull. The greater thickness of the floor of the maxillary sinus, and the position of the roots of the teeth are noteworthy. In the negro race the walls and the floor are much thicker than in the white; therefore, as a rule, the roots of the teeth do not pass up into the wall, or even near the floor of the sinus.

Fig. 201 is an illustration of a tooth which has been perforated by a drill while in the mouth, the operator supposing his drill was passing up the palatal root, instead of which it passed through the pulp chamber, the base of the crown, the alveolar process, and into the maxillary sinus. It will be observed that in extracting it, a portion of the floor of the sinus has been brought away with the tooth. At the time of extraction the patient was suffering from empyema of the maxillary sinus.

The Floor.—The floor of the maxillary sinus is somewhat triangular in its general outline, and is usually uneven, owing to the presence of partial septa and conical elevations over the roots of the various

teeth. These elevations are found over the roots of the molars, sometimes over those of the premolars, and less frequently over those of the canine teeth. As age advances and the teeth underlying the sinus are lost, the floor becomes comparatively smooth. Septa may extend to various heights transversely from side to side or anteroposteriorly (see Figs. 205 and 206), forming deep pockets between them. The

FIG. 199.—Showing where a maxillary sinus has been large at the time of the developing of the roots of second premolar and first and second molar teeth. (*X*-ray by Dr. Pfahler.)

floor of the sinus may descend between the roots of the molar teeth, as shown in Figs. 196 and 197. It may also descend between the teeth (see Fig. 199), a condition much more common among the white races than among negroes. In the negro's skull these elevations over the roots of the teeth are seldom found because of the greater thickness of the bone, so that the floor of the sinus in the negro is usually

smooth. The floor is concave from side to side and slightly so in the anteroposterior direction, as illustrated in Figs. 175, 200, 236 and 237, having thus a basin-like form, and being usually below the level of the nasal cavity (see Figs. 295 and 297).

The Anterior Wall.—The anterior wall is almost a square with rounded corners. It is smooth, with a slight depression, which varies according to the position of the passage of the infra-orbital canal or tube, as shown in Figs. 223 and 230. Occasionally the roots of the

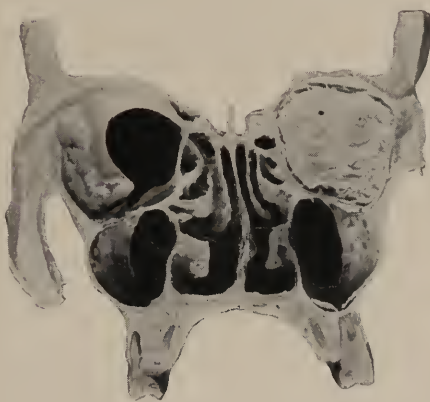


Fig. 200.—Anterior view of a vertical transverse bilateral section of a negro skull, showing a deep alveolar process.

Fig. 201.—Tooth which has been incorrectly drilled through while in the mouth.

canine and premolar teeth are found in this wall. In infancy it contains the follicles of the anterior teeth (see Fig. 107). The anterior dental canal, for the accommodation of the superior alveolar nerves and vessels, passes from the sinus into the wall to reach the anterior teeth except the incisors (see Figs. 229 and 230). The reason this canal is so high up in the bone is that the apices of the roots of the teeth, especially the canines, before eruption or during development and growth, are situated high in the bone. As the teeth descend to their positions in the arch, the nerves and vessels are extended, and the bony tissue

closes around them, leaving for their accommodation a canal along the track traveled by the teeth.

The Outer Wall.—The outer wall of the sinus is more or less triangular and concave on its inner surface; the concavity may extend into the zygomatic bone (see Fig. 271). The wall also extends upward and outward in a slightly curved manner. The surface may be broken up over the buccal roots of the teeth, as shown Fig. 203. The plate of bone forming the outer wall varies in thickness and density and undergoes changes in this particular at different periods of life. In childhood the dental organs of the upper jaw, before eruption, are located in the outer or anterior wall or in the floor of the sinus. Fig. 195 demonstrates the relation of the deciduous teeth to the floor of the sinus at the location of the molars. A little later, as the development of the permanent teeth proceeds, and they are pushed forward preparatory to taking their places in the arch, the outer and lower portion of the maxillary bone appears to be crowded with teeth, as shown in Fig. 107.

The Posterior or Zygomatic Wall.—The posterior or zygomatic wall extends from a line vertical to the centre of the zygomatic arch backward and inward to the proximal or nasal wall. It is concave in a transverse direction and nearly straight in its vertical direction. In youth it is thick, but, like the outer wall of the sinus, it becomes thinner as age advances, until it may be no thicker than a sheet of note-paper.

The Superior Wall or Roof.—The superior wall or roof of the sinus is usually triangular in shape, the base of the triangle being at the inner or nasal wall. It is convex in a transverse direction with the inner edges varying in height. Its junction with the inner wall varies in different subjects. Sometimes it is found on the level of the centre of the floor of the orbit (see Fig. 277). At other times it is higher and near the centre of the inner orbital wall (see Figs. 268 and 298). Its surface is usually marked by a ridge of bone which contains the groove for the passage of the infra-orbital vessels and nerves. This groove commences at the posterior border of the floor of the orbit; continuing forward, it is lost about the middle of the floor, where it

passes into the infra-orbital canal. The ridge extends downward and forward to meet the anterior wall of the sinus. The dipping down of the ridge varies greatly in extent, being scarcely noticeable in some specimens, while in others it extends so far that the canal becomes distinctly tubular in character, passing diagonally through the sinus, carrying the infra-orbital nerves and vessels across the anterior portion, with an open space above the tube. The open space above the sinus extends outward into the lower rim of the orbit, forming an infra-orbital sinus or pocket, a variation which the writer has not seen mentioned in any work on anatomy. The tube-like canal has a thin lamina of bone extending from it to the side of the true sinus. For the above characteristics see Figs. 223, 230, 276, 277 and 361.

The Proximal or Nasal Wall.—The proximal or nasal wall of the sinus is quadrangular in shape, with the inferior angles slightly rounded (see Figs. 204 and 287). In a typical skull this wall is vertical and slightly convex. The lower edge almost always turns slightly outward to join the floor of the sinus, but occasionally it is found dipping in under the floor of the nasal cavity toward the median line, and meeting the floor of the sinus over the palatine process (see Figs. 261, 284 and 297).

The Ostium Maxillare.—The ostium maxillare, an oval-shaped foramen, which affords communication between the sinus and the nasal cavity through the hiatus semilunaris, is usually found on the upper edge of the proximal wall near its anterior portion. It occasionally commences in the roof of the sinus, then passes in a slightly curved direction, terminating in the hiatus semilunaris, as shown in Figs. 279 and 280. In pathological conditions or in extreme old age, there may be two or even more openings between the maxillary sinus and the nasal cavity (see Figs. 183, 184 and 186.

Septa of the Maxillary Sinus.—The shape and size of the maxillary sinus and the character of its partial septa vary so much that it is almost impossible to say what is its typical shape and what are its typical septa. From whatever direction sections are made, variations in shape and size will be found. *Partial bony or membranous septa* are found passing partly across in various directions, but the writer has been

unable to find complete septa of the maxillary sinus, though it is said by some investigators that they exist.

Fig. 204 represents an anteroposterior section near the inner wall of the orbit, showing a maxillary sinus of about the average size for the age of the subject. A portion of the lumina papyracea or os planum is cut away to show the continuation of the outlet of the sinus. A partial bony septum arising from the floor and passing transversely across forms two deep pockets.

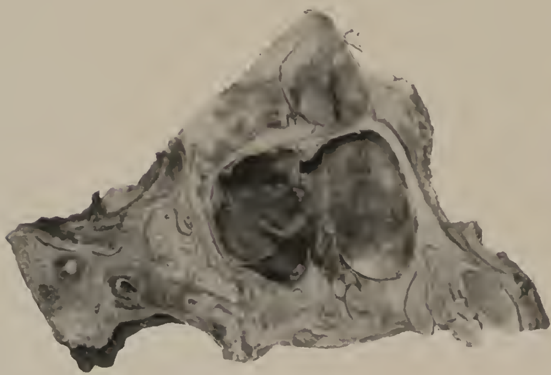


Fig. 202

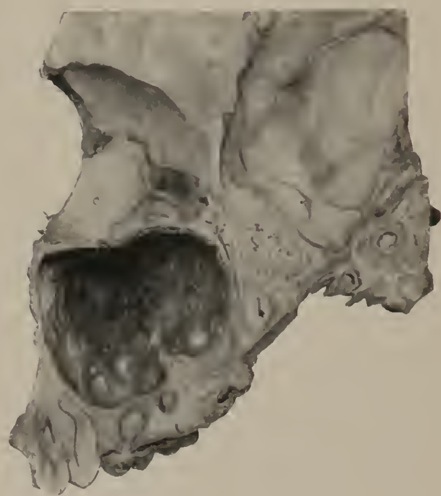


Fig. 203

Figs. 202 and 203.—Two anteroposterior sections made by dividing the orbit and maxillary sinus vertically, showing conical elevations over the roots of the various teeth. The root of the second premolar curves forward. It more commonly curves backward.

Fig. 205 is an anterior view from the skull of an old person. It shows vertical membranous septa of different sizes on the two sides, dividing the lower portion of the cavity into semi-chambers. The septum on the left side is small; that on the right extends nearly to the roof. Resorption has reduced the thickness of the walls of the sinus.

Fig. 206 is from an anteroposterior section through the frontal sinus, the middle of the orbit, and the maxillary sinus, showing an

Fig. 204.—Anteroposterior division through the maxillary sinus.

Fig. 205.—Anterior view of a vertical transverse section from a skull of an old person, showing the thinness of the walls of the maxillary sinus, also membranous septa of the sinus.

incomplete vertical anteroposterior membranous septum with a foramen connecting the external and internal compartments of the sinus. Situated on the membrane are a number of small osteophytes.

Fig. 207 and 208 shows what at first sight might be considered to be a bony division of the maxillary sinus; but close investigation reveals that the crescent-shaped cavity situated on the upper posterior corner of the sinus is the cell of the orbital process of the palate bone cut in

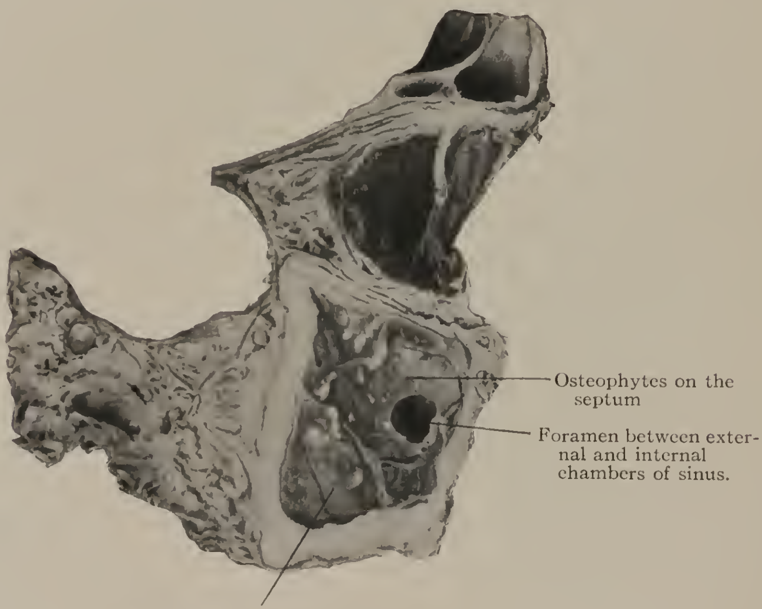


FIG. 206.—A vertical anteroposterior division through the frontal sinus, orbit, and maxillary sinus, showing a partial anteroposterior membranous septum of the sinus.

two. A probe passed through the opening in Fig. 208 would enter the superior meatus of the nose.

Figs. 209 and 210 show two sections of a negro's face through the molar teeth and the middle of the orbit. A sinus may be seen at the upper posterior corner of the maxillary sinus. This opens into the superior meatus of the nose and belongs to the palate bone. The sinus is very small.

Figs. 211 and 212 are taken from the left side of another negro's skull. The section is made in the same region as the last, showing a

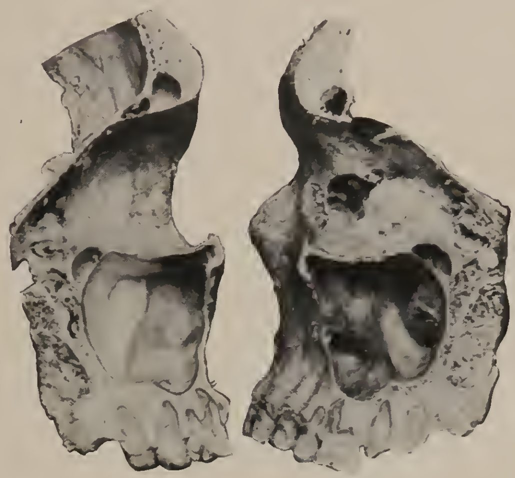


Fig. 207 Fig. 208

Figs. 207 and 208.—Anteroposterior division through the centre of the orbit, maxillary sinus, and molar teeth, showing a crescent-shaped cell at the upper posterior corner of the maxillary sinus.

Fig. 209 Fig. 210

Figs. 209 and 210.—Anteroposterior division through the centre of the orbit, maxillary sinus, and molar teeth, showing a triangular cell at the upper posterior corner of the maxillary sinus.

very small, peculiarly shaped sinus, and a crescent-shaped cell which opens into the superior meatus.

Figs. 213 and 214 are from the right side of the same skull as Figs. 211 and 212, showing apparently two maxillary sinuses. The posterior one

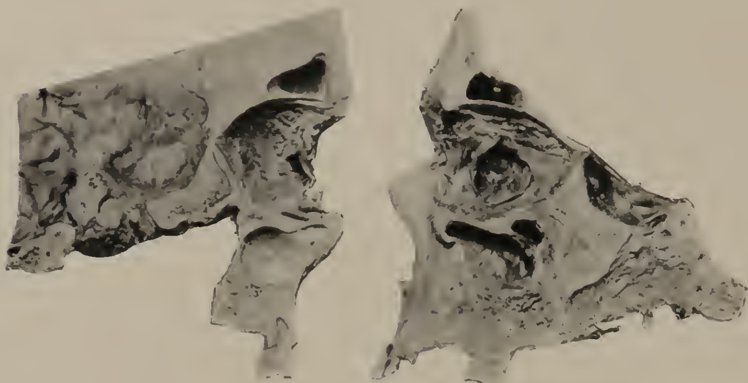


Fig. 211 Fig. 212

Figs. 211 and 212.—Anteroposterior division through the centre of the orbit, maxillary sinus, and molar teeth, showing a peculiarly shaped sinus.

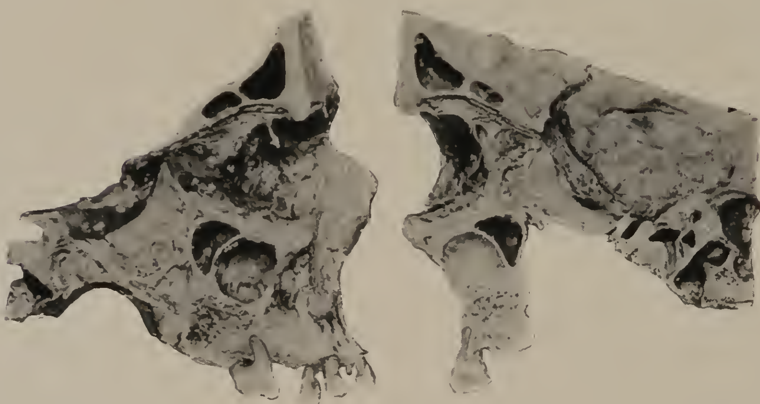


Fig. 213 Fig. 214

Figs. 213 and 214.—Anteroposterior division through the centre of the orbit, maxillary sinus, and teeth, showing an enlarged cell of the orbital process of the palate bone, and a correspondingly small maxillary sinus.

passes around the posterior border of the external surface of the anterior or true sinus. The apparent second sinus is undoubtedly an enlarged cell of the orbital process of the palate bone. The true maxillary

sinus is extremely small. It may be that on account of this the cell was abnormally enlarged to increase the air space of this region, or that the palatal process has encroached upon the space usually occupied by the maxillary bone. The bony septum of this specimen might very easily be mistaken as dividing the sinus into two; but the writer would not thus classify it, as this posterior sinus opens into the superior meatus, as do the other palatal cells just described.

It is a well-established fact that the maxillary sinus is developed by an invagination of the mucous membrane of the middle meatus into the body of the maxilla. If there should be two of these invaginations, it could then be easily accepted that these cells are a divided maxillary

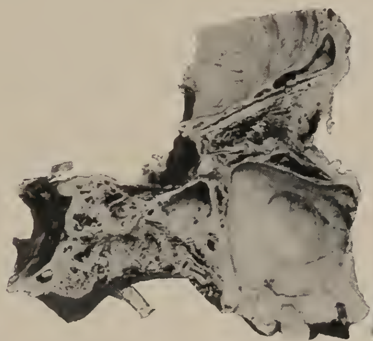


Fig. 215

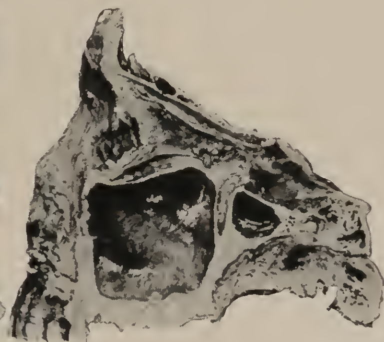


Fig. 216

Figs. 215 and 216.—Anteroposterior division through the centre of the orbit, maxillary sinus, and molar teeth, showing a large maxillary sinus and a large sphenoidal sinus.

sinus; but as the outlet of the posterior one is into the superior meatus, into which the cells of the orbital process of the palate bone open, it seems evident that this is an enlarged palatal sinus or cell, and not a divided maxillary sinus.

Figs. 215 and 216 are from another section made through the molar teeth and the centre of the orbit. Posterior to the maxillary sinus we find another sinus of a different character, which, from superficial examination, might be thought to be related to it or to be an enlarged cell belonging to the palate bone, a probe passed into it leads to the supreme or fourth meatus of the nose, indicating that it may be related to or connected with the sphenoidal sinus. In fact, it is a very

large sphenoidal sinus extending out laterally in a line almost to the outer part of the maxillary bone.

Figs. 217 and 218 are an outer and inner view of a section showing an extremely large sphenoidal sinus. The cut is made through the premolar teeth, and a little to the inner side of the middle of the orbit, exposing the inner wall of the maxillary sinus, the cell of the palate bone, and the sphenoidal sinus, over which is seen the sella turcica. The irregular opening in the anterior clinoid process in Fig. 217 leads to and is a part of the sphenoidal sinus. In Fig. 218 the external wall of the nose will be observed. In the region of the body of the sphenoid

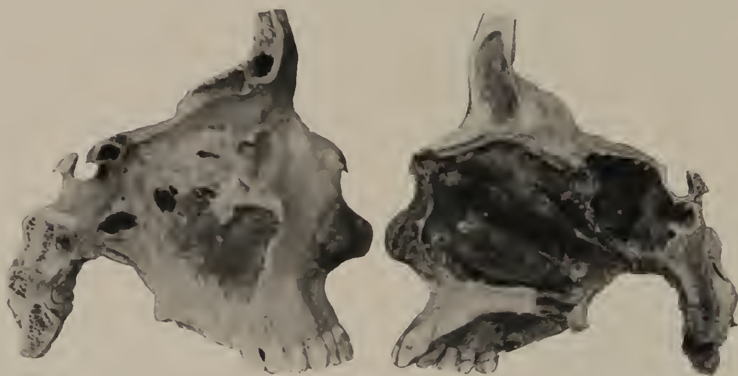


Fig. 217 Fig. 218

Figs. 217 and 218.—Two views of an anteroposterior section. Fig. 217 shows the inner wall of the orbit, maxillary sinus, and openings leading into the sphenoidal sinus. Fig. 218 shows the lateral wall of the nose and a large sphenoidal sinus.

bone is a very large sinus, at the bottom of which will be noticed a space under the sella turcica shown in Fig. 217. This is the largest sphenoidal sinus which has come under the observation of the writer. It extends forward to the cribriform plate of the ethmoid bone; backward to near the basilar process of the occipital bone; laterally on a line with the molar teeth; and superiorly into the anterior clinoid process, with only a very thin plate of bone between it and the floor of the anterior fossa of the brain-case. In such cases the partition between the sphenoidal sinus and the maxillary sinus is so thin and sieve-like that infected fluids will readily find their way from the former to the latter.

In the usual physiological description of the sinus, the fluids are spoken of as passing out of it. It is a question if this be the case under normal conditions. It is more than likely that the law of supply and demand is so balanced that *the parts of the maxillary sinus are kept moist only*, the openings being so arranged at the top as to prevent undue loss of the fluids while the subject is lying on the back or is standing. The openings in the other air cells or sinuses are so arranged as to make almost complete drainage through their most dependent parts.

Dental Relationships.—Because of the close anatomical relation of the maxillary sinus with the tooth-germs and the roots of the permanent teeth, it is evident that the sinus must be more or less influenced by them. As the teeth develop and descend into their normal places, the sinus increases in size. If a tooth situated near the sinus be retarded in its eruption, the development of the sinus is interfered with at that particular point. If the root of a tooth be left in the jaw in old age, resorption immediately over that root will not progress as in the parts from which the roots have been removed (see Fig. 287).

It has been shown how closely the apical portions of the roots of the teeth are often associated with the sinus (see Figs. 196, 197, 199, 202, and 203). This close proximity gives the impression that the maxillary sinus is more often infected from diseased teeth than from any other source, some authorities claiming that three-fifths of the diseases of the sinus are brought about in that way. The writer thinks this a mistake. Though recognizing that diseases of the sinus do arise from the teeth, he believes that, aside from constitutional diseases and malformations, it is more often through the common communication between the nasal cavity, the frontal sinuses, and the ethmoid cells, that infection is conveyed to the maxillary sinus from diseased cells and sinuses above it. He recognizes, at the same time, that the posterior ethmoidal and sphenoidal cells and the cells of the orbital process of the palate bone can also infect the sinus by resorption of the partition between these cavities. It is the writer's observation that there are more cases in which teeth are lost through diseases of the sinus than cases in which the teeth are primarily diseased, causing infection of the sinus and associated cells. In Fig. 197 it

will be observed that the anterior buccal and palatal roots of the first molar tooth pass up into the walls of the sinus. This is the

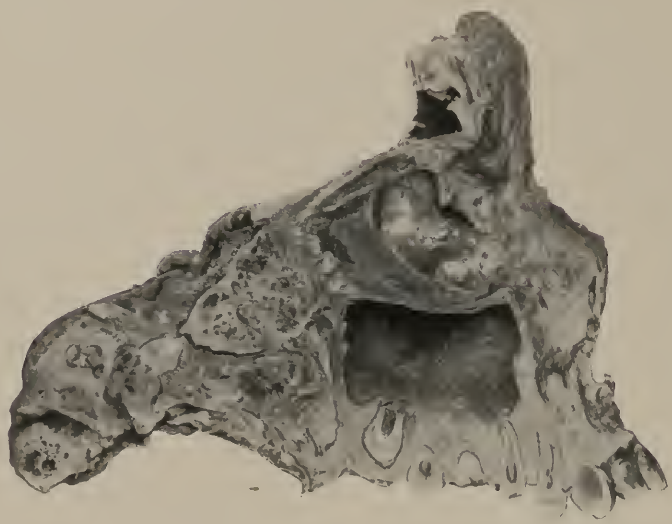


Fig. 219

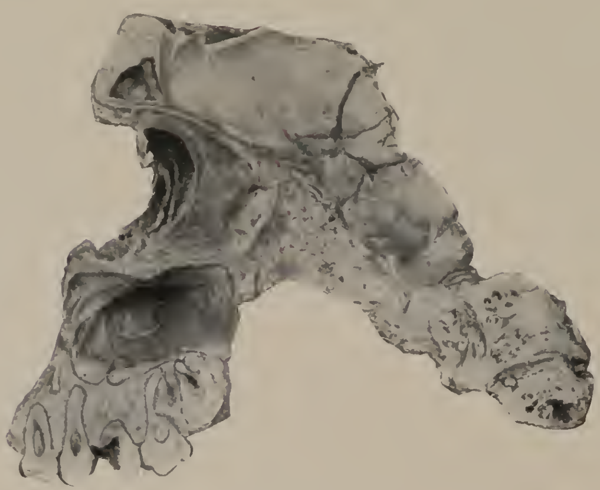


Fig. 220

Figs. 219 and 220.—Anteroposterior division through the orbit, frontal and maxillary sinuses, and molar teeth, showing an undeveloped molar which was causing irritation in the floor of the sinus.

class of cases where diseased teeth may cause infection of the maxillary sinus. If the pulp of a tooth so related to the sinus should become devitalized and infected, the parts around the apical foramen might also become infected and abscesses occur. From the close proximity of the points of the roots to the sinus, it might be supposed that these abscesses would break into it, as they occasionally do. Other examples of infection through diseased teeth in no way militate against the idea that the teeth are not first in importance as factors in causing disease of the sinuses.

It is, however, clear that pus or infected matter will pass in the direction of the least resistance. When the investing tissues of a tooth become so infected, the osteogenetic function of this region is to stimulate renewed activity, with the result that a new layer of bone is produced which covers these parts and protects this cavity, so that abscesses, with but few exceptions, point and break into the mouth.

Careless operation by the dentist sometimes causes infection of the sinus, as drilling through the tooth and the floor of the sinus, or forcing the root of a tooth into the sinus, through fracture of the wall in an unskilful effort to extract, or carelessness in driving artificial crowns or bridges upon the teeth or roots.

Figs. 219 and 220 are views of an undeveloped and unerupted third molar which was causing irritation in the floor of the sinus.

Figs. 221 and 222 are from the opposite side of the same skull, showing a similar condition and with an abscess which has burrowed under the mucous membrane near the roots of the first molar tooth.

Figs. 223 and 224 are views of an anteroposterior section of the upper jaw with the first molar decayed and the pulp-chamber of the tooth open. The root-canal has been infected and the infection has been carried into the sinus. In this case there is evidence of a productive periostitis upon the floor of the sinus, which has caused a thickening of bone over the apex of the root. At a later period suppurative inflammation has occurred and perforated the floor.

Fig. 225 is a view of the floor of the sinus and the nasal cavity. In the middle of the sinus there is a conical elevation with an opening in the centre exposing the apex of a tooth. In this case new bone has

been formed over the diseased root, but at some subsequent time the bone has been broken down and the sinus has become infected.

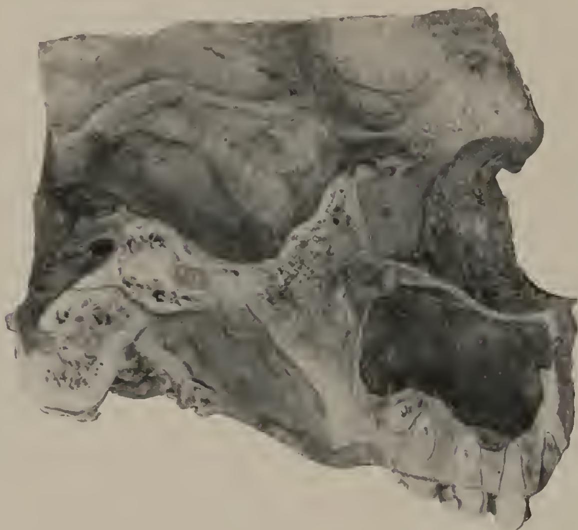


Fig. 221

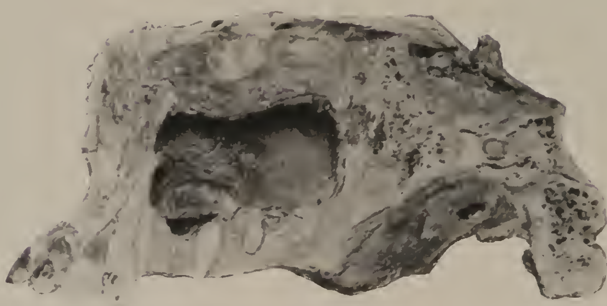


Fig. 222

Figs. 221 and 222.—Anteroposterior division through the orbit, frontal sinus, maxillary sinus, and molar teeth, showing a similar condition as in Figs. 219 and 220. An abscess has burrowed under the mucous membrane near the roots of the first molar tooth.

Fig. 226 is a vertical transverse section of the sinuses and nasal cavity. In the floor of the right sinus the conical portion of the bone, covering the infected tooth, has been cut through its centre,

exposing the end of the root in the infected region, the condition being somewhat similar to those shown in Figs. 223 and 225.

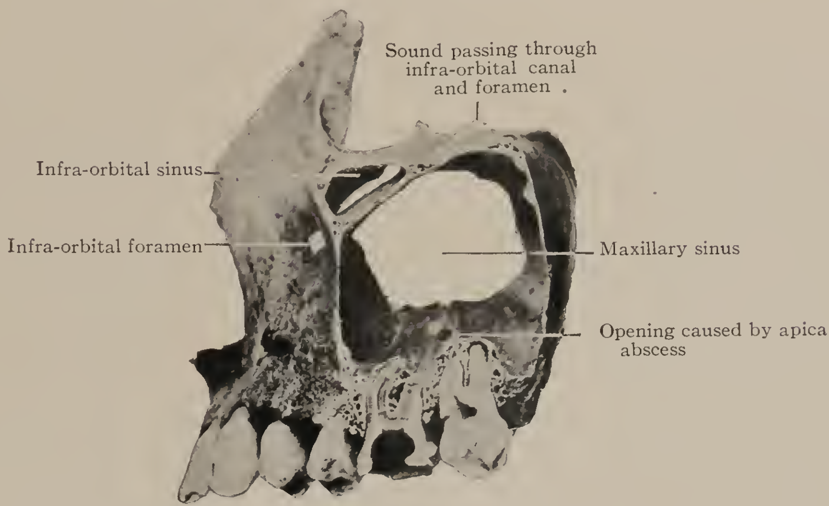


FIG. 223

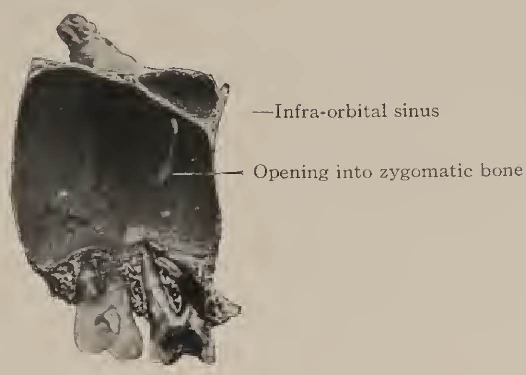


FIG. 224

FIGS. 223 and 224.—Anteroposterior division of the maxilla, showing opening of a dental abscess within the maxillary sinus and an infra-orbital sinus.

Figs. 227 and 228 was made from the left maxilla of the same skull from which Figs. 223 and 224 were taken. The pulp of the first molar was devitalized. In 228 an enlargement of the infected root is seen.

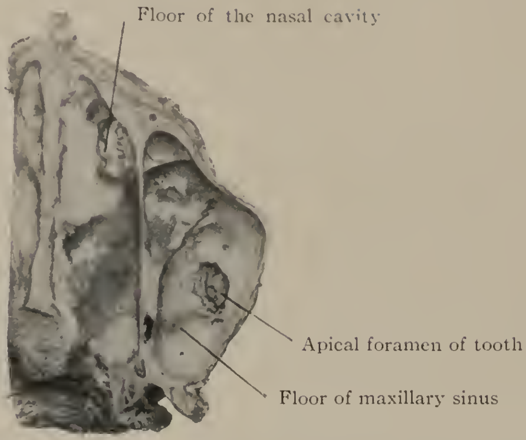


FIG. 225.—Horizontal section above the right floor of the nasal cavity and maxillary sinus, showing the opening of a dental abscess in the floor.

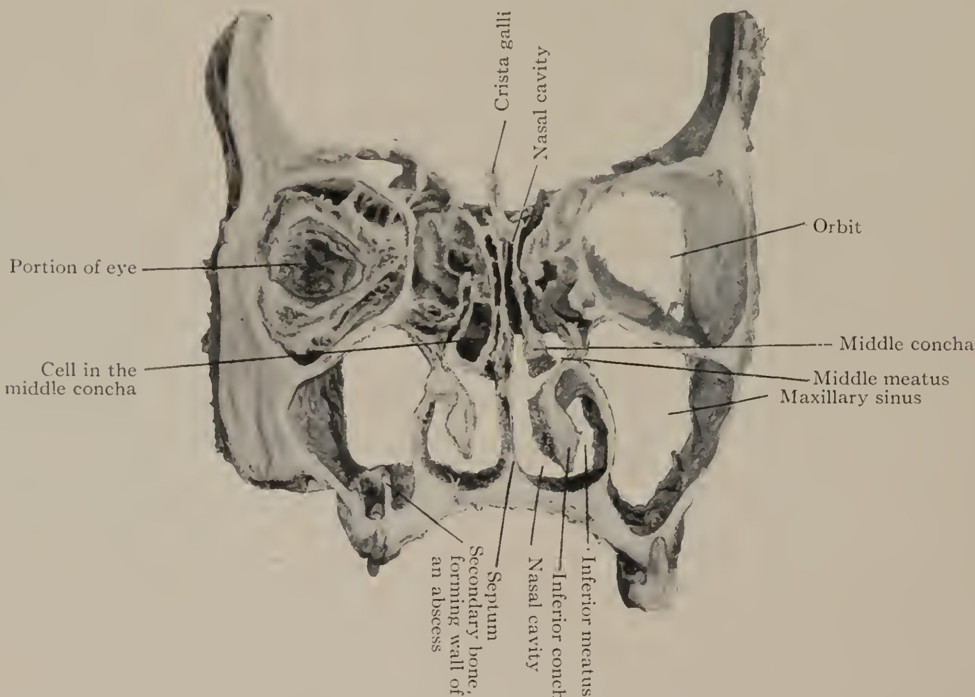


FIG. 226.—Anterior view of a vertical transverse section in the region of the crista galli, middle of orbit, and molar teeth, showing effect of dental abscess in floor of maxillary sinus.

An examination of the hard palate shows that the discharge of the abscess was made into the mouth, which the writer believes is the

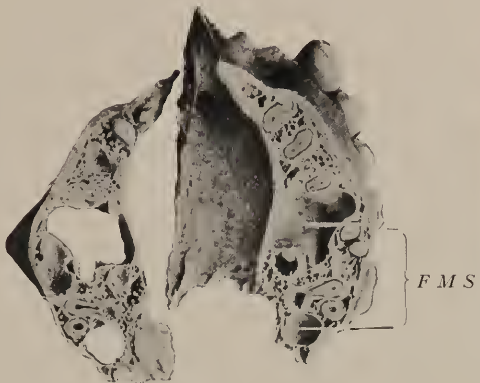


Fig. 227

Fig. 228

Figs. 227 and 228.—Horizontal sections through the maxillary sinus. *F M S*, floor of the maxillary sinus. In Fig. 228 there is an exostosis over the position of an infected root of the first molar tooth. In Fig. 227 the cap of bone covering the root has been removed, exposing the end of the root and a fistula extending downward, opening into the roof of the mouth.

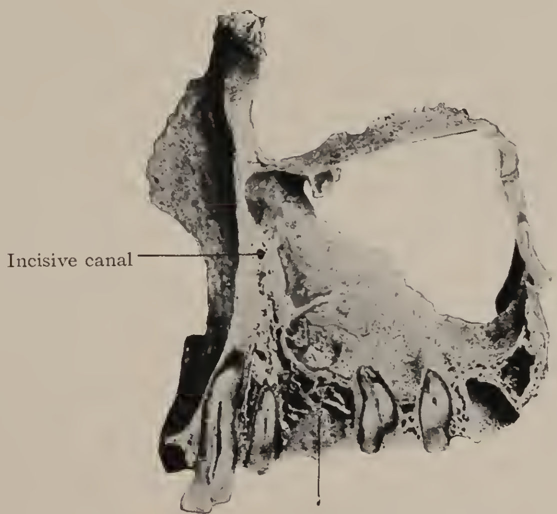


Fig. 229.—Alveolar process.

usual outlet for apical abscesses in the upper jaw—of course recognizing that they occasionally open into the sinus.

The vessels of nourishment to the maxillary teeth do not pass through and along a canal in the cancellated tissue as they do in the mandible, but in a groove on the outer wall of the maxillary sinus (as shown in Fig. 230), from which are given off branches to the apices of the roots of the teeth, many of the latter being covered with only a thin plate of bone. It is through the vessels of this region that infection can be conveyed from the teeth and alveolar process to the maxillary sinuses or *vice versa*.

It has been shown by these examples how numerous are the variations of the maxillary sinus in shape, size, and position, and in its rela-

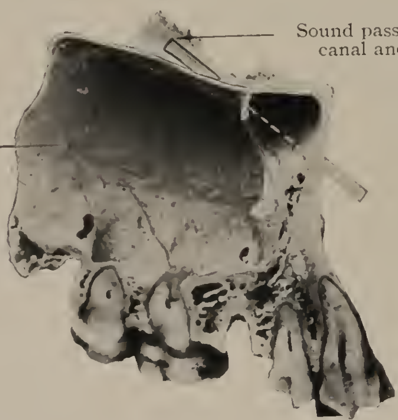


FIG. 230.—Anteroposterior division through the maxillary sinus and the teeth, showing an infra-orbital sinus above the canal.

tion to the mouth and teeth, the nasal cavity, the frontal sinus, the ethmoidal cells, the cell of the orbital process of the palate bone, and the sphenoidal sinus. The variations are most important to the dentist and rhinologist. In the field of oral surgery, so many complications often arise in the extraction and treatment of teeth that a thoroughly scientific knowledge of the results of all recent research in this region is absolutely necessary.

Surgical Relations.—In the extraction of the upper molar teeth great care should be exercised, because, as has been shown, where the sinus is large, extending downward and inward between the

roots of the teeth, as seen in Fig. 199, if undue force should be exerted, not only the tooth grasped by the forceps, but also a great portion of the floor with other teeth attached is liable to be carried away. Examples of the results of such accidents are shown in Figs. 231, 232 and 233. Figs. 231 and 232 are from specimens broken away with the ordinary forceps, and Fig. 233 is from a specimen of the work of the old-fashioned turnkey. When using much force in placing artificial bridges or crowns upon the teeth immediately beneath the sinus, there is danger of breaking the floor in subjects where the walls are thin. When the pulps of the teeth have become diseased and infected, the infection may pass out of the apical foramen

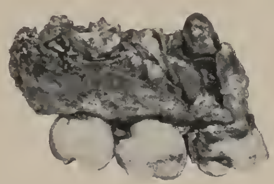


Fig. 231

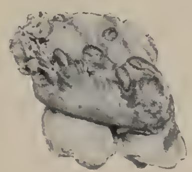


Fig. 232

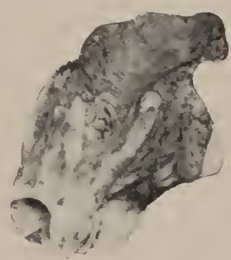


Fig. 233

Figs. 231, 232 and 233.—Three pieces of bone with molar teeth that have been accidentally broken away with part of the floor of the maxillary sinus in extraction; Figs. 231 and 232 with ordinary forceps, Fig. 233 with an old-fashioned turnkey.

into the tissues immediately surrounding the root, and thence into the sinus, as has before been mentioned. In cleansing the root-canal there is some danger of passing the instrument through the apical foramen directly into the sinus. Certain diseases of the teeth caused by inflammation of the periodontal membrane with abscesses threatening to open into the mouth, sometimes disappear suddenly, although no fistulous opening into the mouth has formed. When this occurs an abscess has frequently found an opening into the sinus. Diseases of the maxillary sinus are liable to produce disturbances in the teeth, as their blood supply passes along the floor of the sinus and through the wall. Branches of the trigeminal nerve accompany the vessels, and these also are liable to become deranged functionally.

The maxillary sinus is on a lower plane than any of the other sinuses and cells associated with the nasal cavity, and has its outlet in the upper anterior portion; when the hiatus semilunaris is blocked below or posterior to the opening of the sinus, it becomes engorged with the fluids which have no other normal exit, thus producing pressure upon its walls and upon the nerves and vessels passing through it. It is in such cases that additional openings are found leading from the maxillary sinus (see Figs. 183, 184, 185, 186, 187 and 188).

Pathological Conditions.—Pathological conditions of the maxillary sinus vary in almost every aspect, and arise from a great diversity of causes, of which, may be mentioned:

(1) Pathological conditions of the parents of the child at time of conception.

If either parent should have any constitutional disease which could be transmitted to the offspring, or if a parent should have an abnormally-shaped face such as compressed dental arches, narrow nasal cavities, irregularities of the pneumatic spaces, etc., the child would begin its existence with a strong predisposing cause for pathological conditions which might continue throughout life.

(2) Constitutional disturbances during the growth and development of the child.

Among the general constitutional disturbances that predispose to pathological conditions of the sinus are syphilis, the acute exanthemata, as scarlet fever and measles, and disorders of nutrition, as rickets, etc.; also local disturbances, as infected or enlarged tonsils, adenoids, nasal polypi, or anything else that tends to obstruct or close the nasal passages, thus shutting off proper breathing spaces, drainage, and ventilation. These conditions should all be taken into consideration when studying the pathology and treatment of the maxillary sinus.

(3) Infection by continuity from the nasal mucosa.

This is one of the most frequent sources by which a pathological condition of the maxillary sinus is brought about, the severity of the condition depending upon the character and quality of the infected matter transmitted. The maxillary sinus, like all open cavities which are covered with epithelium, is immune to infection to a great extent,

but repeated or constant exposure to infected matter will finally result in a diseased condition, producing a discharge of the type of the particular microörganisms introduced. Therefore anything that affects the mucosa of the nose will have its influence by direct action upon all the associated pneumatic spaces. The effect of an ordinary cold may not reach the sinus, but if the patient suffers from repeated coryza continued for long periods, it will be affected finally and remain so even after the membrane of the nose has recovered; because when the ciliated epithelium of the sinus becomes diseased, it has not the power to convey the infection and broken-down tissue upward to the natural outlet.

(4) Infection through the blood supply.

The blood supply of the greater portion of the sinus comes from the same source as that of the teeth, namely, the superior alveolar artery, which gives off small branches to the teeth, the alveolar process and the greater portion of the mucous membrane of the sinus. The veins which commence in the alveolar process, the teeth and the mucous membrane of the sinus, anastomose quite freely with one another. A similar arrangement of the bloodvessels exists in the region of the outlet of the sinus into the nose. Consequently it will be seen that infection from one region will easily be carried throughout all the area having the same blood supply. If the frontal sinuses or ethmoidal cells become diseased, fluids may be diverted into the maxillary sinus, which will in turn become infected. Again, if the sinus should become infected through the blood supply to the mucous membrane which receives its nourishment through various vessels, or if the mucous membrane should become infected through diseased teeth or osteomyelitis or any other sourse, the infection produced would pass from the maxillary sinus to the frontal sinus, the ethmoidal cells and tissues in close relation to those parts. There are but few cases of osteomyelitis on record arising from the walls of the maxillary sinus *per se*.

(5) Foreign bodies are occasionally found in the sinus which produce a pathological condition. They are usually discovered in cases where the sinus has been previously diseased and treated.

(6) Cysts, polypi, impacted or misplaced teeth, odontomata, osteophytes, malignant and benign tumors are strong predisposing factors toward pathological conditions of the sinus, and should be carefully considered in all diagnoses of sinus troubles, especially as cysts and tumors of this region are more or less obscure in their incipiency. Impacted or deflected teeth are also often difficult to diagnose, if one be not thoroughly familiar with the variations in the anatomy of the parts, or if a thorough radiographic inspection be omitted.

Treatment of Pathological Conditions of the Maxillary Sinus.—As the causes of pathological conditions of the maxillary sinus are so various, it is evident that etiology, diagnosis and treatment must cover a wide range. The principal thing is to make a correct diagnosis and study of the etiology, and when such is obtained, on general principles, the treatment should be to remove the cause, whether it be from constitutional disturbances, diseased teeth, necrosis of the bone, impacted teeth, odontomata, dental or other cysts, polypi, new growths, malignant or benign, foreign bodies, diseases communicated through the circulation, from adjacent parts that are pathological, direct infections from other pneumatic spaces, or from any diseases associated with the nasal cavity.

All diseases of the maxillary sinus that are caused by the teeth, or any diseases of its walls, except the nasal, should be treated through the mouth, this usually avoids the contamination of the nasal cavity and its associated parts. On general principles, all diseases of the maxillary sinus caused by diseases of the nasal side of its walls should be treated from the nasal standpoint.

Occasionally where a pathological condition originates in the nasal region and is treated and cured, the sinus may become infected and remain diseased, in such cases treatment through the mouth is more appropriate than through the nose.

When the maxillary sinuses have complicated septa creating pockets inaccessable through the nasal cavity (see Fig. 295), or in cases where the maxillary sinuses extend downward far below the level of the nasal floor (Figs. 284 and 297), treatment may have to be undertaken through the mouth.

If Figs. 276 and 277 be examined they will give illustrations of pockets and anatomical conditions of the maxillary sinus that would make it most difficult to treat especially if it should be required to curette the parts. An infra-orbital sinus may be seen under the outer and anterior portion of the floor of the orbit; in case of disease of this sinus it would be most difficult to reach through the nasal cavity. In Fig. 287 there are two deep pockets that would be difficult to reach through the nasal cavity, while through the alveolar process it would be comparatively easy and would avoid the interfering with the nose.

Figs. 284 and 297 show cases where the floors of the maxillary sinuses are far below the level of that of the nasal cavity.

An ordinary opening into the maxillary sinus through the mouth heals up very quickly, especially if the disease of the sinus becomes cured, which is usually accomplished if the trouble has been caused by diseased teeth.

CHAPTER IX.

THE FRONTAL SINUS.

The frontal sinuses are usually two irregular-shaped cavities situated in the lower part of the facial portion of the frontal bone and in the process forming the roofs of the orbits, with a thin lamina of bone between them. They vary considerably in size, shape, position, and number.

Development.—They appear about the second year after birth and are formed by an invagination from the upper anterior portion of the hiatus semilunaris and by a dissolution of the tissue between the outer and inner plates of the frontal bone, the excavations for the formation of these sinuses as well as for the various other cells and sinuses being carried on through the agency of the osteoclasts. The sinuses continue to increase in size as age advances. They are lined with mucous membrane and communicate with the nasal cavities through the infundibulum and the hiatus semilunaris. There are skulls in which frontal sinuses do not exist; there are other skulls in which there is but one sinus that may be very small, or it may extend from one of the external angular processes beyond the medial line of the frontal bone and upward to a point above the level of the frontal eminences or posteriorly over the orbit almost to the optic foramen. It sometimes spreads outward and backward terminating in the great wing of the sphenoid bone; it may be found not only in the ascending portion of the bone, but extending downward and backward may become one common cavity with the anterior ethmoid cells and the maxillary sinus (see Figs. 247 and 296). There are usually two frontal sinuses, each having an independent outlet into the nasal cavities, but specimens exist in which three or more sinuses are present, all in the ascending portion of the bone and each having its independent outlet. The portions which pass over the orbit might be called supra-orbital

sinuses, especially if they have complete partitions and outlets other than the one which occupies the ascending portion of the bone.

Figs. 234 and 235 show a large left frontal sinus, which passes over to the right of the medial line, leaving but little room for the right sinus in its normal position, as is seen in Fig. 235. Often, in such cases, the opposite side will extend its air space in some other direction to make up for the loss caused by the invasion.

Fig. 234

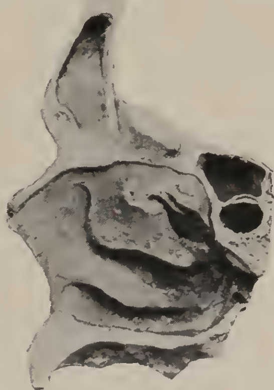


Fig. 235

Figs. 234 and 235.—Lateral walls of the nasal cavity, showing the left frontal sinus extended over to the right of the medial line.

Figs. 236 and 237 are made from Fig. 235, cut through the centre of the orbit, showing that the frontal sinus has extended back over the orbit to the region of the optic foramen. It has also extended outward under the zygomatic process of the frontal bone.

Figs. 238 and 239 are made from a skull where the frontal sinus has extended upward under the region of the frontal eminence and downward to the middle of the orbit or almost on a level with the upper portion of the maxillary sinus.

Fig. 240 is an illustration of two large frontal sinuses, extending from one zygomatic process of the frontal bone to the other, with but a thin complete septum between. This septum is not in the centre, but is carried over the left side. The sinuses pass backward over the greater portion of the orbits, and upward toward the frontal

eminence. There is quite a depression over the frontal crest, which is very large in this specimen. There are also several partial septa running in various directions in the two sinuses.

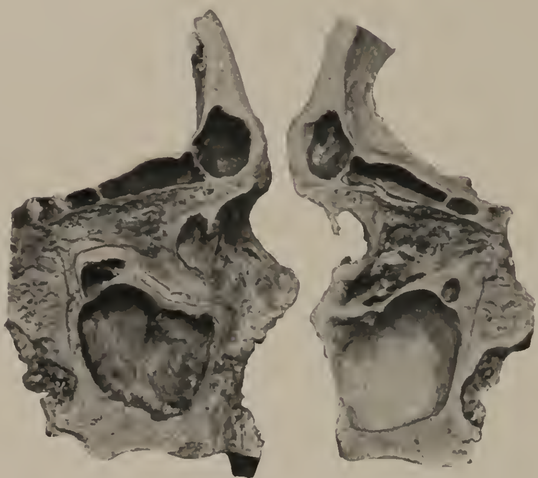


Fig. 236 Fig. 237

Figs. 236 and 237.—Two anteroposterior sections (made from Fig. 170) through the frontal sinus, centre of orbit, maxillary sinus, and cell of the orbital process of the palate bone, showing the frontal sinus extending backward over the orbit to the region of the optic foramen. It also extends under the zygomatic process of the frontal bone.

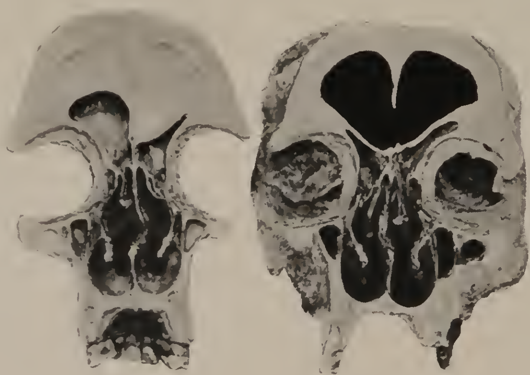


Fig. 238 Fig. 239

Figs. 238 and 239.—Two vertical transverse sections through the frontal sinuses and nasal cavities, showing the frontal sinus extending below the level of the middle of the orbit.

Occasionally the frontal sinus extends into the crista galli forming a cell in that process (see Figs. 269, 281, 282, 292, 293, 294, 295 and 296).

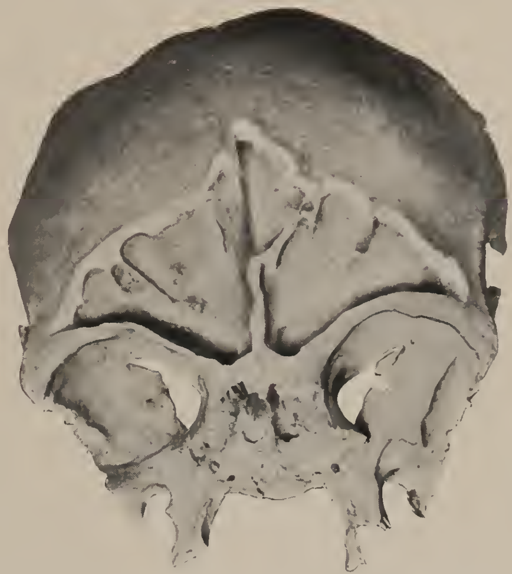


FIG. 240.—Large frontal sinuses extending from one zygomatic process of the frontal bone to the other.

FIG. 241.—Two sections of the supra-orbital region, showing no frontal sinus.

Fig. 241 is made from two sections taken from the supra-orbital region of the skull. The upper figure shows that the anterior portion of the frontal bone has been removed from the region of the superciliary ridges, exhibiting no indication of the sinus in the ascending

portion of the frontal bone. The lower picture shows no evidence of the sinuses passing into the horizontal portion or over the orbits.

Fig. 242 is made from a specimen having only a right frontal sinus, which extends unbroken far over to the left. This sinus passes partly over the orbit and has but one outlet.

Fig. 243 shows two rather typical frontal sinuses with two outlets and a complete septum near the medial line. There is also one partial septum near the medial line, and one partial septum in each sinus forming two pockets near the zygomatic process. The right sinus measures horizontally 35 mm., the left 30 mm.; the depth of the right sinus is 42 mm. and the left 35 mm.

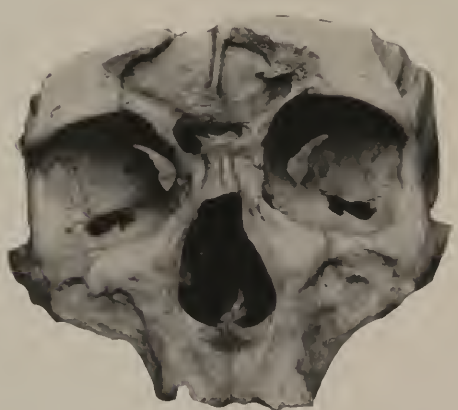


Fig. 242.—Anterior view of skull with bone removed, exposing only one frontal sinus.

Fig. 243.—Anterior view, showing two frontal sinuses.

Fig. 244 shows three complete frontal sinuses with three individual outlets and two complete septa. The two lateral sinuses pass backward well over the orbits.

Fig. 245 is made from a skull that has four frontal sinuses, with four independent outlets and three complete septa. Some writers would class the two middle sinuses as anterior ethmoidal cells which had invaded the frontal bone. If these cells should exist without the two larger sinuses they would then be called frontal sinuses by these same writers.

Fig. 246 is made from a specimen containing five frontal sinuses and having four complete septa. Four of the sinuses extend well upward to about the same height.

Fig. 244.—Anterior view, showing three frontal sinuses.

Fig. 245.—Anterior view, showing four frontal sinuses.

Fig. 246.—Anterior view, showing five frontal sinuses.

Fig. 247 is a posterior view made from a specimen having two large frontal sinuses with a complete septum. The right sinus extends back over the orbit and down through the region of the anterior ethmoidal cell, continuing into the maxillary sinus and making one common cavity of the frontal sinus, the anterior ethmoidal cells and the maxillary sinus.

Fig. 248 is made from a skull having two large frontal sinuses. There appear to be three sinuses in the picture, but the septum on

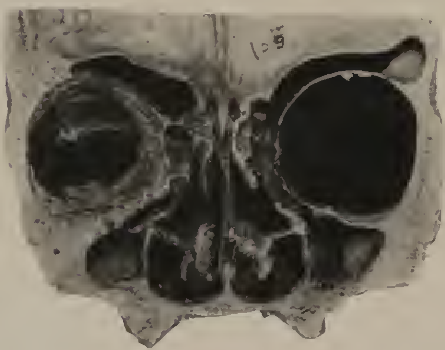


FIG. 247.—Posterior views, showing two large maxillary sinuses. The right one forming a common cavity with ethmoid cell and maxillary sinuses.

FIG. 248.—Anterior view, showing two frontal sinuses, the right one very large extending well over to the left side.

the right is incomplete, making but one sinus on that side, which is very large, extending from the right zygomatic process transversely well over to the left side, and measuring 65 mm. Its depth from the top to the outlet is 45 mm., and it extends well back over the orbit 40 mm.; the left sinus passes outward and backward to about one-half the distance of that on the right side.

Fig. 249, from a horizontal section above the orbit, shows a transverse section of a large left frontal sinus, measuring 67 mm. from the left zygomatic process to a position over the centre of the right

infra-orbital foramen, without a septum. The right frontal sinus, measuring 40 mm., has several small incomplete, nearly horizontal septa, making a number of horizontal pockets.

Fig. 250 is made from a transverse section of the face with a portion of the bone removed to expose the frontal sinuses. The right sinus is extremely large, extending from the right zygomatic process over toward the left and measuring 67 mm., leaving but a slight space for the left frontal sinus, which measures 15 mm. The

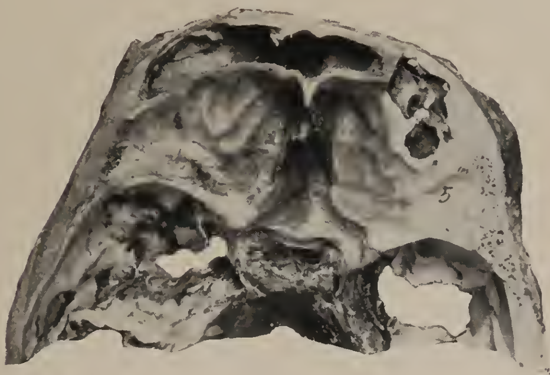


Fig. 249.—Horizontal section above the orbit.

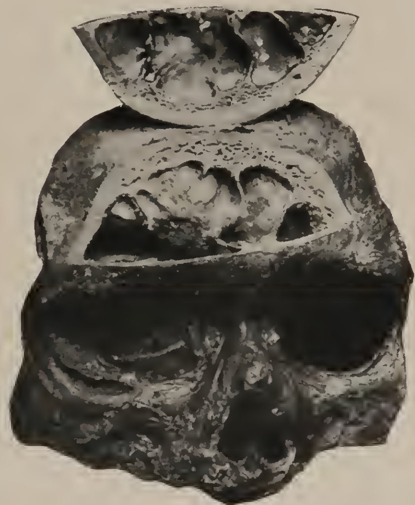


Fig. 250.—Anterior view, showing a large right frontal sinus, the left sinus is very small.

septum between these sinuses has an inclination of about 45 degrees. The right sinus also extends well back over the orbit and into the crista galli.

Fig. 251 is made from a transverse section of the face with a portion of the bone removed, showing two very large frontal sinuses which extend backward over the orbits, where they are divided by several incomplete septa. They also extend downward and communicate directly with the maxillary sinuses. The right and left sinuses measure horizontally 50 mm. and their depth is 40 mm.

Fig. 252 is a posterior view of the frontal sinuses, showing two incomplete septa. The incompleteness of the latter is more than likely due to pathological conditions.

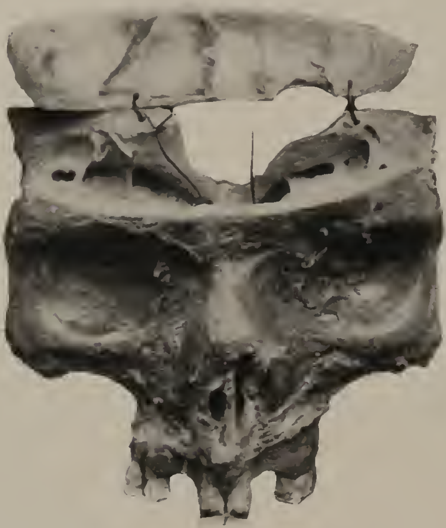


FIG. 251.—Anterior view, showing two very large frontal sinuses extending upward and well back over the orbits.

FIG. 252.—Posterior view, showing two incomplete septa.

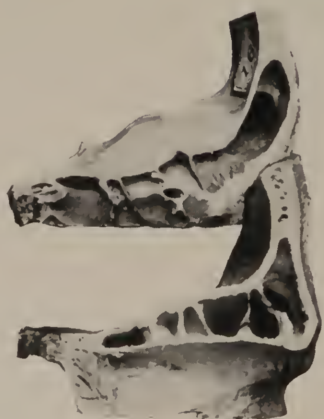


FIG. 253.—Two lateral views of two specimens, showing large frontal sinuses.

Fig. 253 is made from two specimens, showing lateral views of the frontal sinuses. The lower picture is a sagittal section cut near the centre of the orbit, showing in the anterior portion a lateral view of

the frontal sinus divided into five pockets, all of which have one common outlet. The sixth or posterior cell communicates with the upper meatus of the nose. The upper picture is also a sagittal section cut to the median line of the os planum of the ethmoid bone. It shows a frontal sinus extending backward nearly to the optic nerve which is seen in position in the optic foramen.

The skull pictured in Figs. 254, 255 and 256 has the largest pneumatic spaces of any head I have examined, not only of the frontal sinus, but of the supra-orbital, sphenoid, and maxillary sinuses. The right frontal sinus commences in the right temporal fossæ at a point near the articulation of the frontal bone with the great wing of the sphenoid

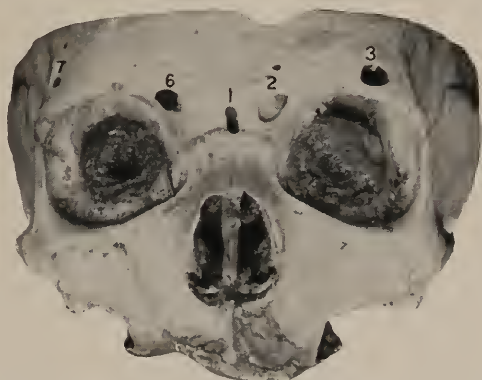


Fig. 254.—An anterior view of a skull with frontal sinuses extending from within the great wing of the sphenoid bone forward to the frontal bone then backward to the left sphenoid bone.

(see point marked 8, Fig. 255). It extends forward and across the skull to the opposite side, then a little backward, terminating near the left great wing of the sphenoid (see point marked 4, Fig. 256).

The frontal portion of this great space is divided into four compartments, three of which have a separate outlet, while the fourth is connected to one of the others by a small foramen which is placed low down in the sinus.

As already stated the right frontal sinus commences at a point marked 8, in Fig. 256, in the temporal fossæ and extends upward, forward and inward almost to the nasion, measuring 55 mm. The right supra-orbital sinus commences in the zygomatic fossa (see point marked 9, Fig. 255) or in the right wing of the sphenoid bone; it passes

upward, forward and inward over the orbits (see point marked 7, Fig. 255). Its outlet is in the anterior and lower portion of the right frontal sinus. It measures in length 55 mm. There are also several other sinuses or cells over the anterior portion of the orbits with independent outlets.

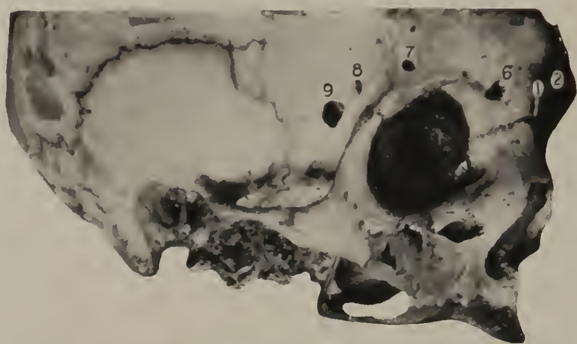


Fig. 255.—Right lateral view of skull shown in Figs. 254 and 256.

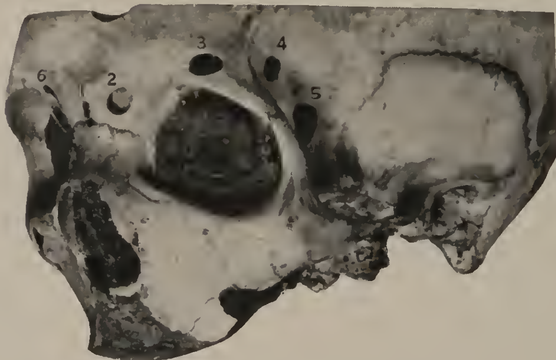


Fig. 256.—Left lateral view of skull shown in Figs. 254 and 255.

The left frontal sinus commences in the temporal fossa at a point marked 4, in Fig. 256. It then passes upward, forward, and to the right, to the wall forming an intermediate frontal sinus. It measures 48 mm. The sinus is divided into two compartments by a septum lying at an angle of 35 degrees from the horizontal. At the lower and median end of this septum there is a small foramen which allows the two compartments to communicate with one common outlet into the nasal cavity.

CHAPTER X.

THE ETHMOIDAL AND OTHER CELLS WHICH HAVE THEIR FINAL OUTLET IN THE NASAL CAVITY.

The ethmoidal cells are situated principally between the two orbits. Fig. 257 is an upper view of a horizontal section cut through the centre of the orbits and the upper part of the nasal cavities,

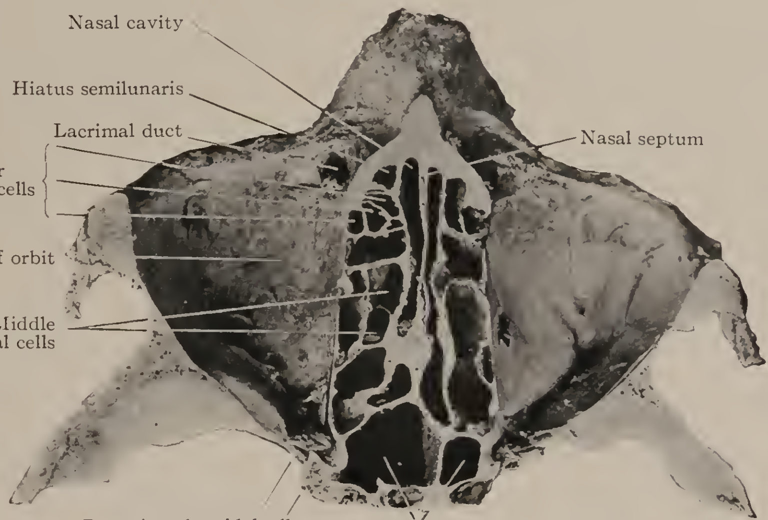


Fig. 257.—Upper surface of a horizontal section cut through the orbits and upper part of nasal cavity.

showing clearly the position of many of the cells, as does also Fig. 258. Many of these ethmoidal cells are formed by the union of the orbital plates of the frontal bone and the ethmoid bone and between the ethmoid bone and the maxilla; others are within the ethmoid alone. They are divided into three groups—anterior, middle, and posterior.

The anterior ethmoidal cells are the smallest of the three divisions. They open by several small orifices into the anterior portion of the

hiatus semilunaris. Occasionally a chain of cells is found opening one into another and finally into the hiatus.

The middle ethmoidal cells vary more in size than either the anterior or the posterior. The inner covering or wall of the cells is spheroidal in form and is known as the bulla ethmoidalis. It is situated in the upper portion of the lateral wall of the hiatus semilunaris, and extends downward and inward toward the unciform process. The openings of the cells are in the outer portion of the bulla ethmoidalis and they discharge into the hiatus semilunaris.

The posterior ethmoidal cells are usually two or three in number. They are found on about the same plane as the anterior and middle ethmoidal cells, are irregular in shape, and usually have their general outlet into the superior meatus.

THE ORBITAL PROCESSES.

The cells of the orbital processes of the palate bones are two in number, one on each side. Each cell is small and situated below the posterior part of the floor of the orbit. It is, like many other air cells, irregular in shape and size. It opens into the third or superior meatus. It occasionally extends backward near to the sphenoidal sinus or outward around the posterior wall of the maxillary sinus, from which it is separated by a thin plate of bone (see Figs. 213 and 214).

THE SPHENOIDAL SINUSES.

The sphenoidal sinuses are two, one on each side, irregular in shape and size, situated in the body of the sphenoid bone (see Figs. 257, 258 and 280). The septum between them is generally deflected to one side or the other (see Figs. 257, 279 and 280). Incomplete septa may also be found at the posterior portion of these cavities, which divide them into several incomplete compartments (see Figs. 279 and 280.) Sometimes these sinuses may extend backward to the basilar process of the occipital bone, or forward to the cribriform plate of the ethmoid bone, or laterally into the base of the great wings of the sphenoidal bone, or into the clinoid process (see Figs. 217 and 218). They are

lined with mucous membrane, which is continuous with the lining of the upper and posterior portion of the nasal cavities.

The greater portion of the anterior surface of the body of the sphenoid bone is open, these openings are covered to a great extent

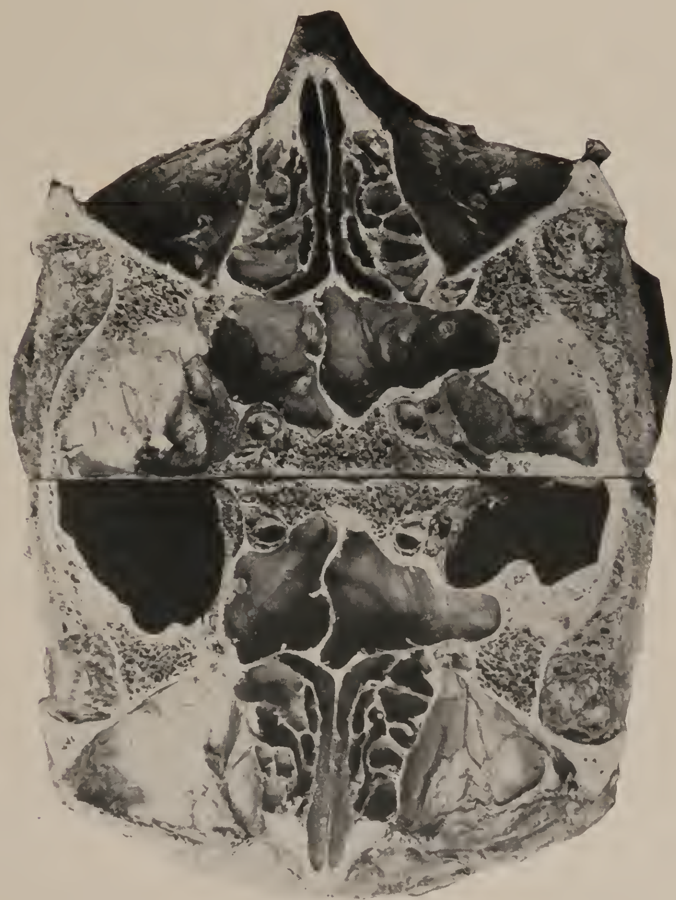


Fig. 258.—Horizontal section through the orbits, ethmoid cells and sphenoidal sinuses.

by the sphenoid conchas (sphenoidal turbinate processes) which are two thin triangular-shaped plates. The posterior surface is concave and faces the body of the sphenoid bone to which it becomes attached. The anterior surface is convex and is associated with the ethmoid in

front, forming a portion of the roof of the nasal cavity, through each of these plates is an ostium that gives passageway from the sphenoidal sinus to the highest meatus of the nose. Pathological conditions arising through abnormal irregularity of these conchæ are difficult to diagnose and treat.

Fig. 258 is from a horizontal section cut through the centre of the orbits, ethmoid cells and sphenoidal sinuses. The sphenoidal sinuses are large with a slightly curved septum between them. Cross sections of the carotid canal may be seen posterior to the sinuses.

CELL OF THE CRISTA GALLI.

Sometimes a cell is found within the crista galli (see Figs. 269, 281, 282, 292, 293, 294, 295 and 296). In such a case the opening is in front and communicates with one of the frontal sinuses. It might be termed an extension of the frontal sinus into the crista galli.

CHAPTER XI.

VARIATIONS IN THE ANATOMICAL STRUCTURES OF THE FACE.

THE variations exhibited in the internal anatomy of the face are so common that it is sometimes difficult to differentiate the normal from abnormal anatomy. Some of the most important and common

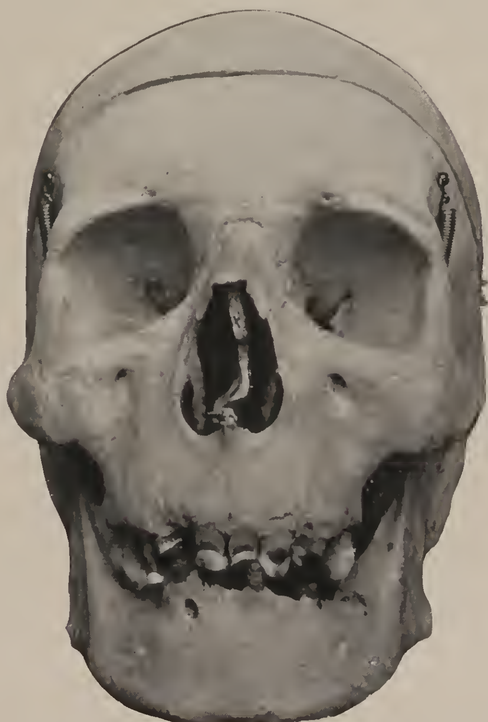


FIG. 259.—Front view of asymmetrical skull, showing the right side more fully developed than the left side.

variations found in the writer's dissections are described in the following pages.

Fig. 259 is a front view of a skull which has an asymmetrical arch

of the mouth. The greater portion of the teeth have been lost in early life. The canine fossa of the right side is lacking, the face being

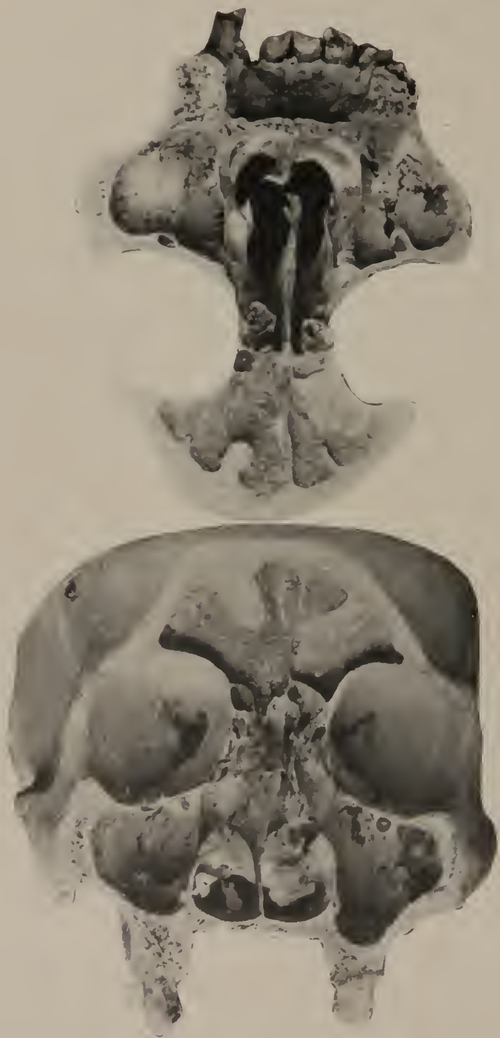


FIG. 260.—Vertical transverse division of Fig. 259, showing a larger maxillary sinus on the left side than on the right.

very prominent at that point. The teeth have not been in normal position. The septum is deflected toward the left side. In a skull

of this character the internal structures will usually be decidedly unsymmetrical. One might suppose that a large sinus would be found under the fulness of the canine fossa, but in this particular case it is rather small.

Fig. 260 represents a vertical transverse section of the skull shown in Fig. 259. It will be seen that the right sinus is smaller than the left, the fulness of the region in the infra-orbital foramen and the canine fossa being due to the thickness of the bone. The frontal sinus of this specimen is large and extends downward between the orbits lower than usual.

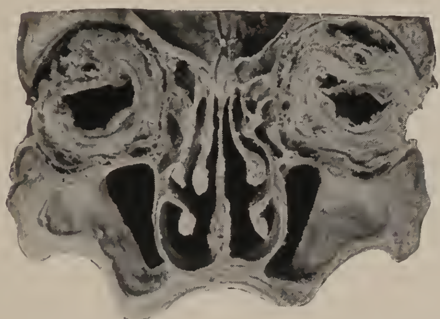


Fig. 261.—Anterior view of a vertical transverse section of skull through the centre of the orbits, nasal cavity, and maxillary sinus, the lower inner corners of the maxillary sinuses passing partly under the nasal cavity.

Fig. 262.—Posterior view of a vertical transverse section of skull in region of second premolar, showing lack of symmetry in nasal cavity and maxillary sinuses, with the septum and "spur" passing over the inferior concha.

Fig. 261 exhibits a condition occasionally met with, the floor of the sinus dipping downward and passing partly under the floor of the nose. The same condition will be found in Figs. 284 and 297. Resorption has taken place between the plates forming the floor of the nose and the roof of the mouth. Sinuses like these could be drained directly by an opening through the palatal surface of the mouth. In skulls of this character the vault of the mouth is high.

Fig. 262 exhibits an entire lack of symmetry between the nasal cavity and the sinuses of the right and left sides, the inferior meatus of

one side being closed anteriorly by the deflected nasal septum and the "spur" upon it. In such cases as this, inspissated mucus often collects and the outlet of the nasolacrimal duct may be interfered with.

Figs. 263, 264 and 265 are from the same subject as Fig. 262. An instrument passed through the axis of the alveolar process, shown in

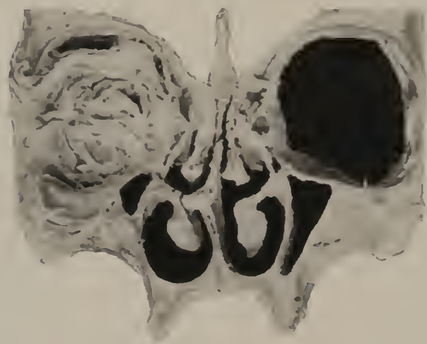


Fig. 263.—Anterior view of a vertical transverse section of the skull shown in Fig. 262, showing an asymmetrical condition of the two sides.

Fig. 264.—Posterior view of section shown in Fig. 263.

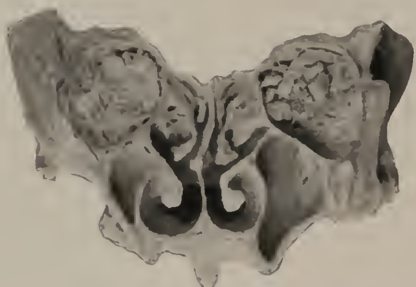


Fig. 265.—Anterior view of vertical transverse section cut from the posterior part of the nasal cavity and maxillary sinus. It is from the same skull as Figs. 262, 263 and 264.

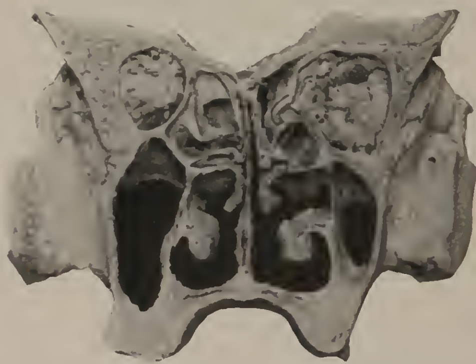


Fig. 266.—Anterior view of a vertical transverse section, showing lack of uniformity in the two maxillary sinuses.

the right side of Fig. 264 or the left side of Fig. 263 or Fig. 265, would perforate the nasal cavity, instead of the floor of the maxillary sinus.

Fig. 266, which is taken from a different skull, shows an almost straight septum, with bilateral symmetry as regards the nasal cavity;

the maxillary sinuses vary, however, throughout the depth of the skull. On the right side the sinus would not be reached by drilling through the alveolar process, while on the left side the sinus is just above the process, and the floor is below the level of the floor of the nasal cavity.

Fig. 267 is from a vertical transverse section in the region of the first premolar. The septum is almost straight, but there is a great variation in the maxillary sinuses. The lateral wall of the nasal cavity of the right side is also the outer plate of the maxilla, the floor of the sinus being on a much higher plane. In the floor of the left nasal

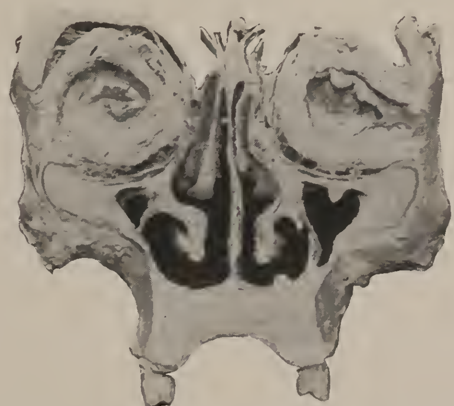


FIG. 267.—Anterior view of a vertical transverse section, near the first premolar, showing variation in the maxillary sinuses and the nasal cavities.

cavity is an elevation which covers a tooth root, probably that of a supernumerary tooth. In Figs. 263 and 267 the nasal walls of the right inferior meatus pass outward under the maxillary sinus to the facial portion of the maxillary bone. In Figs. 270 and 283, the same condition will be observed on both sides. In the event of attempting to drill into the maxillary sinus from the canine fossa in such cases as are represented in these figures, as is sometimes advised, the opening would be made into the nasal cavity instead of into the sinus.

Fig. 268 is a vertical transverse section made in the region of the second molar, the nasal cavities are large with a straight septum, the

FIG. 268.—Posterior view of a vertical section made in the region of the molar teeth, showing small sinuses and large nasal cavity and narrow dental arch.

FIG. 269.—Two vertical transverse sections. The surfaces shown are divided from each other. Variations are shown in the maxillary sinuses and nasal cavity. A cell is also shown within the crista galli, which opens into the frontal sinus.

dental arch is narrow and the maxillary sinuses small, they do not extend downward in the direction of the teeth and alveolar process.

Fig. 269 shows two sections from the same skull as Fig. 268, cut more anteriorly, in the region of the premolars. The parts are almost symmetrical. The crista galli has been cut transversely, showing within its walls a cell of considerable size, opening into the frontal sinus.

Fig. 270 is made from the skull of an aged person, in which the bones have become much resorbed. It is comparatively symmetrical, with the floor of the sinus much higher than usual, and the nasal cavity extending outward to the external portion of the maxillary bone.

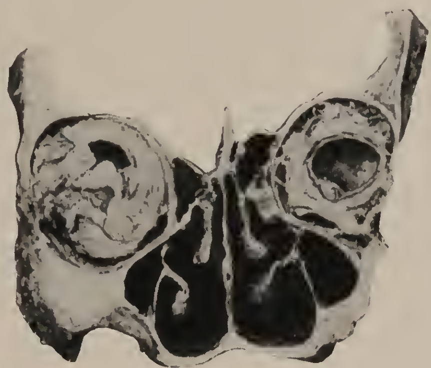


FIG. 270.—Anterior view of a vertical transverse section from the skull of an aged person, showing large nasal cavities with small maxillary sinuses.

Occasionally in surgical practice abscesses are found opening on the face in the region of the zygomatic bone. These are usually looked upon as of superficial origin, but sometimes when carefully examined they are found to be associated with the maxillary sinus. Fig. 271 will partly explain why, in some cases, abscesses of the maxillary sinus open at this point. The section is made at the region of the maxillo-zygomatic articulation. The maxillary sinus passes far into the zygomatic bone, extending backward into the temporal process.

Fig. 272 is from a skull in which the nasal cavity extends outward over the alveolar process until it reaches the outer wall of the maxilla. The points of the palatal roots of the first and second molars appear in the floor of the nasal cavity. The floor of the maxillary sinus is well up on the side of the bone.

Fig. 273.—A sagittal section of a greyhound's skull, showing the nasal cavity extending to the outer wall of the maxilla, no true maxillary sinus is found, though the inferior concha helps to partly shut off a space which might be named the conchomaxillary sinus.

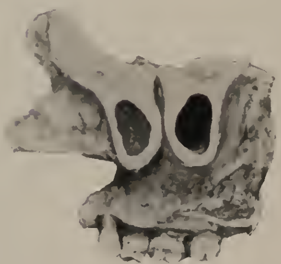


FIG. 271.—Section through the maxillozygomatic articulation, showing that occasionally the maxillary sinus passes into the zygoma.

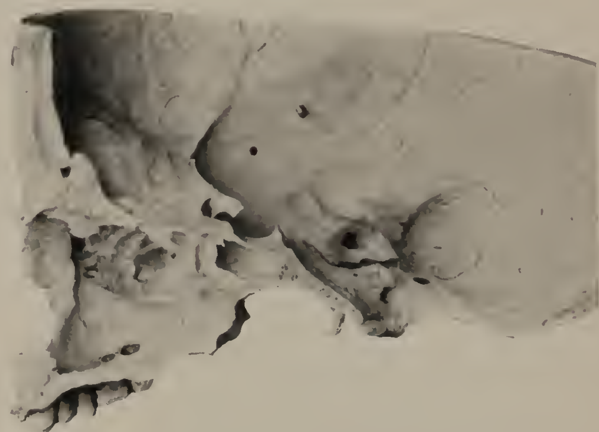


FIG. 272.—Interior view of the external wall of the nasal cavity, showing portions of the palatal roots of the first and second molar teeth in the floor of the nose.

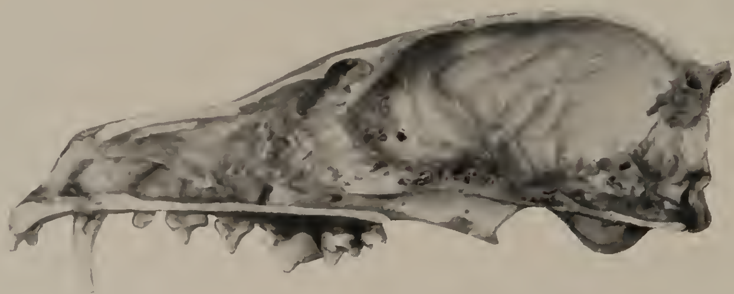


FIG. 273.—Sagittal section of a greyhound's skull.

Fig. 274.—A sagittal section of a badger, showing conditions similar to that of the greyhound, Fig. 273. The root of a tooth is seen in the floor of the nasal cavity similar to the roots shown in the human nasal cavity, Fig. 272.

Fig. 275 is a picture from the external or facial surface of Fig. 272, which illustrates that the resorption of the alveolar process from

over the buccal roots of the teeth may progress while that portion of the bone along the free margin of the process is left intact.

Figs. 276 and 277 show a vertical transverse section of the upper jaw. In Fig. 277 the roof of the maxillary sinus is almost horizontal, which is a very unusual condition. The illustrations show what is

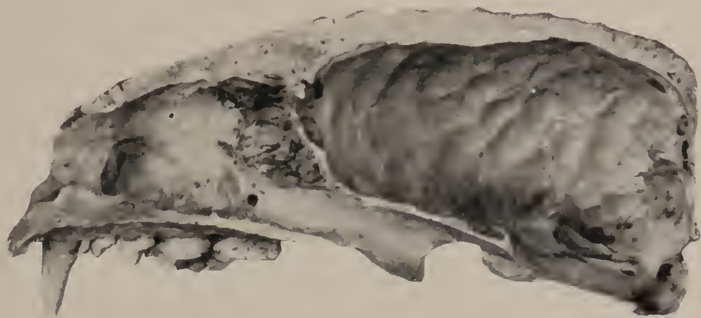


FIG. 274.—Sagittal section of a badger's skull.

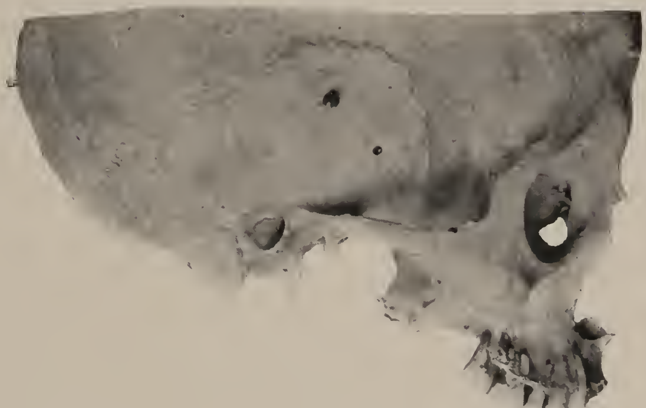


FIG. 275.—External view of facial surface of Fig. 272, showing the resorption of the outer part of the alveolar process, leaving a line of bone near the free margin of the process.

apparently a division of the sinus into two, the smaller or outer division forming an infra-orbital sinus. This condition is caused by a bony septum passing down from the centre of the floor of the orbit, cutting off a portion of the sinus, and forming an extra chamber, which of course is continuous with the true sinus. In the centre of the septum-like wall is

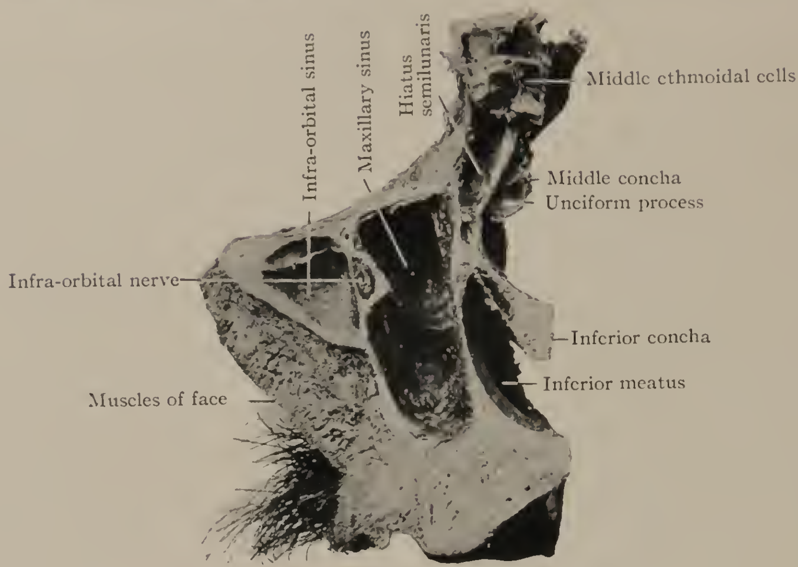


Fig. 276.

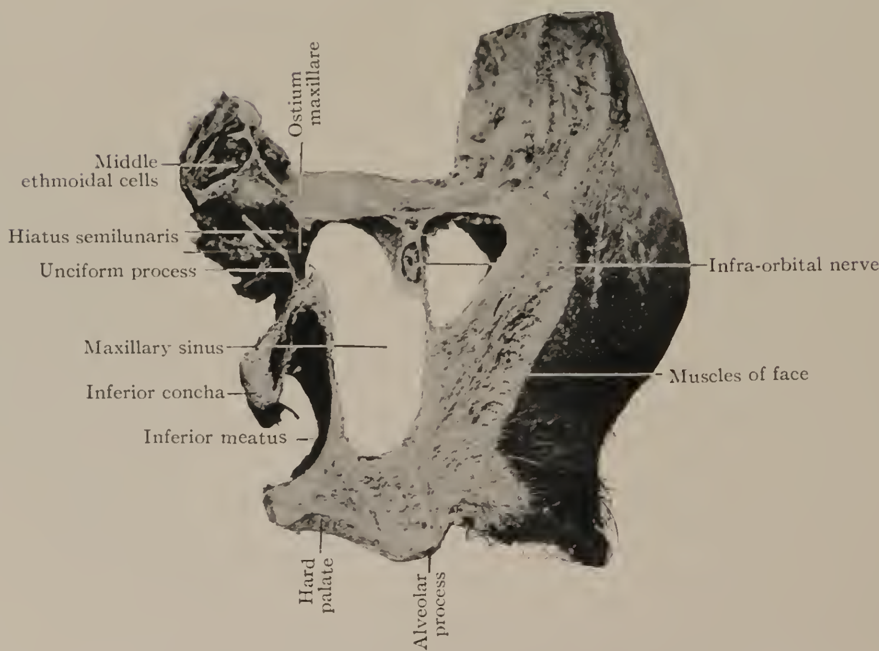


Fig. 277.—Vertical transverse division of the upper jaw.

a tube or canal conveying the infra-orbital nerves and vessels. Above this, and at the junction of the septum with the floor of the orbit is an adjunct infra-orbital canal and nerve. At the upper inner corner of Fig. 277 is the normal opening of the maxillary sinus, the ostium maxillare, communicating with the hiatus semilunaris. This section beautifully illustrates how the hiatus semilunaris is bounded on the inner side by the unciform process, on the outer side by the wall of the sinus, and above by the bulla ethmoidalis, containing the middle ethmoidal cells. Should the bulla become enlarged, or the mucous membrane of this region be swollen, the hiatus would be closed and

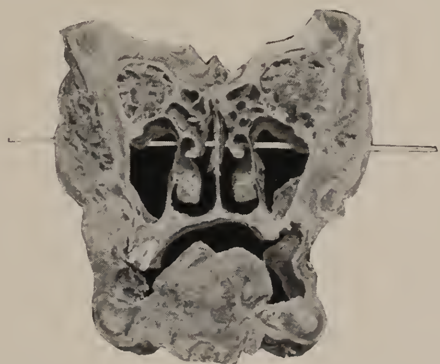


Fig. 278.—Posterior view of vertical section through the orbits, maxillary sinuses, posterior ethmoidal cells, and the third molar teeth.

fluids could not pass directly into the middle meatus but would be thrown into the maxillary sinus.

Fig. 278 illustrates a vertical transverse section of the face. It gives a good sectional view of the posterior ethmoidal cells. The white line is on a level with the floor of the orbit in the anterior portion of the section. It will be noticed, as is often the case, that the roof of the maxillary sinus runs up as it passes backward until it is far above the level of the floor of the orbit at its anterior margin.

Figs. 279 and 280 show two sections made by a horizontal transverse section a little below the roof of the sinus. In this case the commencement of the ostium maxillare is within the roof. It passes backward and inward to the hiatus semilunaris. A probe placed in

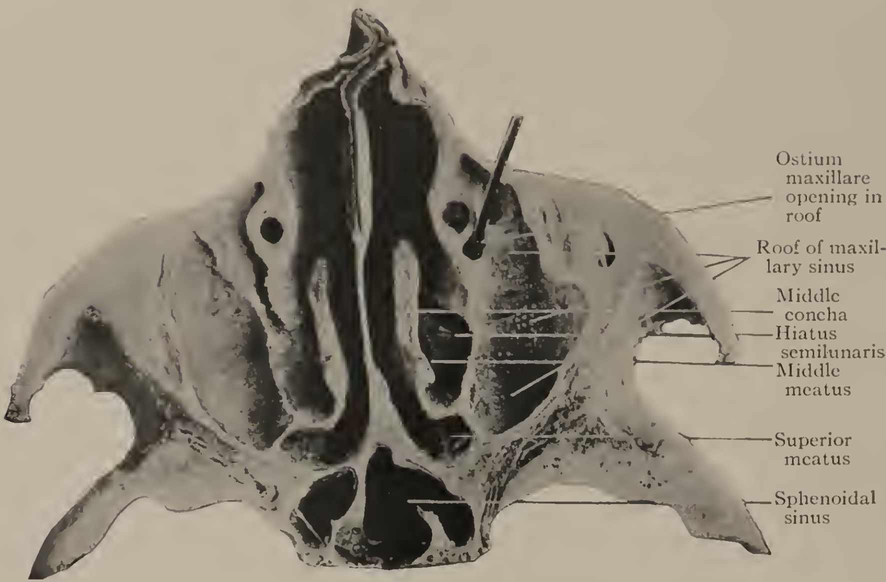


Fig. 279

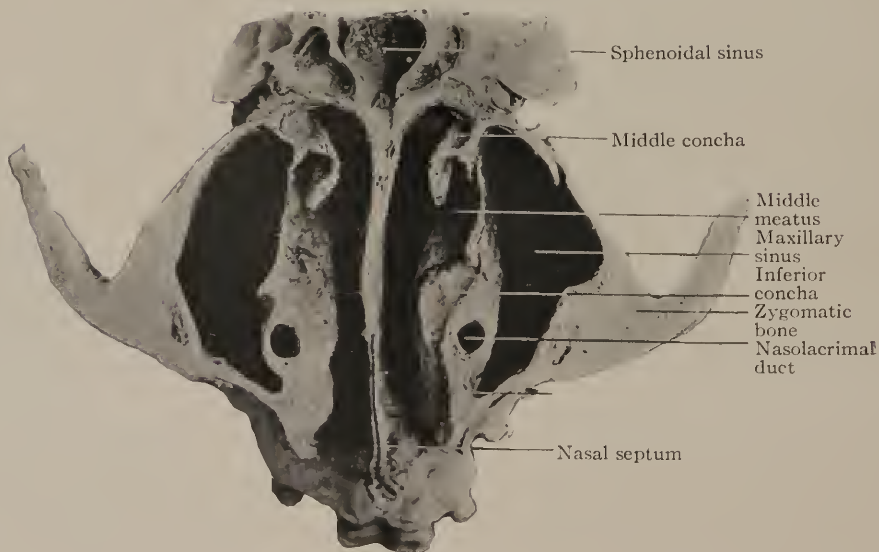


Fig. 280

Figs. 279 and 280.—Two illustrations. Fig. 279 shows the roof of the maxillary sinus and upper portion of the nasal cavity; Fig. 280 shows the maxillary sinus and nasal cavity.

the left ostium maxillare indicates its position. Immediately to the left of the probe is a section of the nasolacrimal duct. On the opposite side, the lower wall of the right ostium has been removed.

That the great variations found in the nasal cavities and maxillary sinuses may be fully appreciated, skulls of widely different types have been selected and photographed together.

Figs. 281 and 282 give a posterior view of two sections made from different skulls. They show great variations in the depth of the face, and the size, shape, and position of the maxillary sinus. In Fig. 281 the sinuses are much smaller than in the shorter-faced picture, Fig. 282. In Fig. 281 the septum has a spur extending outward until it comes in contact with the inferior concha, the frontal sinuses pass well down below the level of the centre of the orbits. In both illustrations there are distinct cells in the crista galli, which open anteriorly into the frontal sinuses.

Figs. 283 and 284 were made in the same manner as Figs. 281 and 282, and show two sections cut in about the same position from two different skulls. There is again a great difference in the depth of the faces. The maxillary sinuses in Fig. 283 are small and placed high up, allowing the lower portion of the nasal cavity to extend outward over the alveolar process. In Fig. 284 the maxillary sinuses are large, their floors extending down below the floor of the nasal cavity, and passing inward over the roof of the mouth, so that only a small space is left between the sinuses. The enlarged sinuses allow but little room for the nasal cavities.

Figs. 285 and 286, also made from two different skulls, show variations in the depth of the nasal cavities. A good illustration of the fourth meatus and a part of a fifth is shown in Fig. 285.

Figs. 281, 282, 283, 284, 285 and 286 serve to show several variations in the sinuses and nasal cavities. Similar comparisons between the sphenoidal and frontal sinuses, and the ethmoidal and other cells, would show as marked differences. Bilateral variations almost equally extensive are found in the individual skull, except as to the depth of the face. The diagnosis and surgery of such cases must follow in accordance with the variations existing in the anatomical structures.

In Fig. 287 is shown an anteroposterior section illustrating the close relation between the frontal and maxillary sinuses. It also shows that in this instance fluids could pass from the frontal sinus and eth-

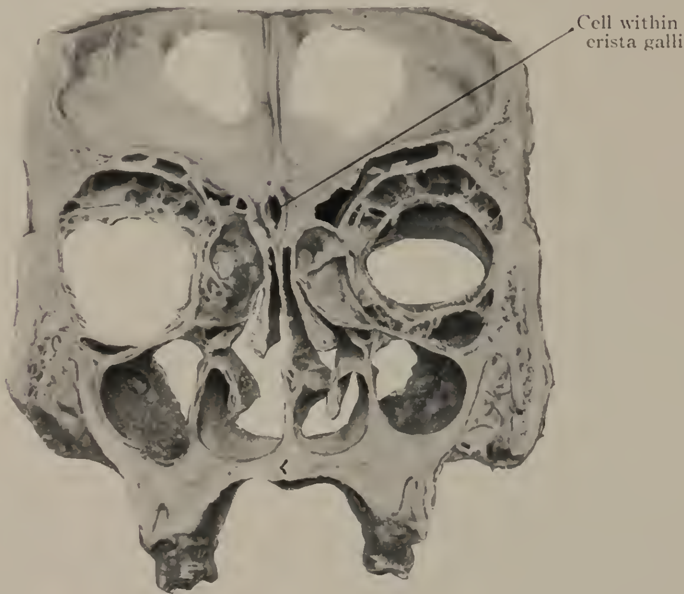


Fig. 281

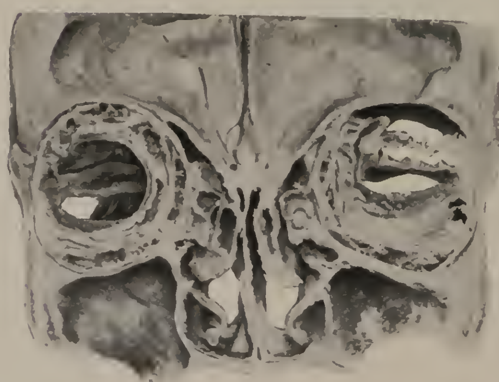


Fig. 282

Figs. 281 and 282.—Posterior views of two vertical transverse sections made from different skulls in about the same anatomical region, showing great variations as to the depth of face, and size and shape of the maxillary sinuses and nasal cavities.

moidal cells into the maxillary sinus. Of the two probes passed through the ostium maxillare, one goes directly through the posterior portion

Fig. 283

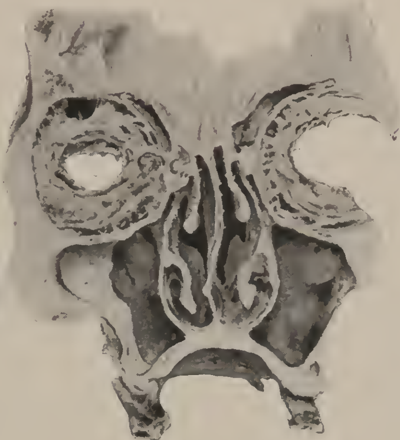


Fig. 284

Figs. 283 and 284.—Posterior views of two vertical transverse sections made from different skulls in about the same anatomical region, showing great variations as to the depth of face, and size and shape of nasal cavities and maxillary sinuses.

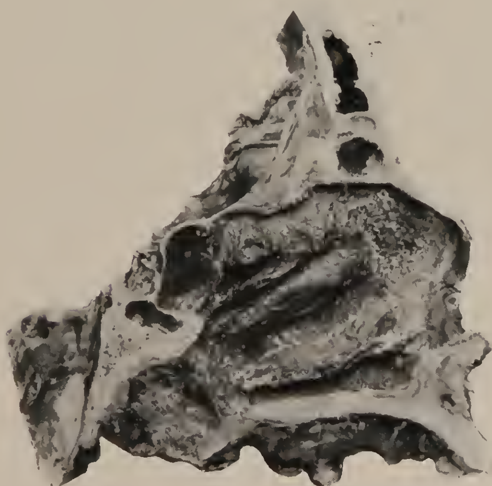


Fig. 285

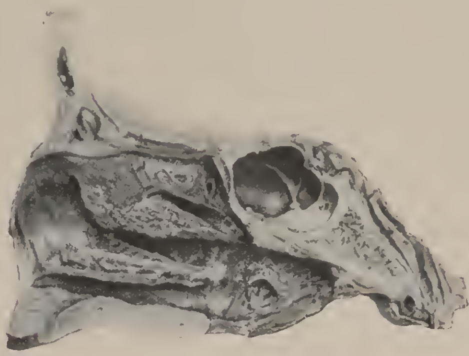


Fig. 286

Figs. 285 and 286.—Two illustrations from different subjects, showing great variations as to depth and size in the external wall of the nasal cavities. Fig. 285 shows four meatuses.

of the hiatus semilunaris into the middle meatus, while the other (the vertical one) passes into the hiatus semilunaris, then upward and a little forward into the frontal sinus.

Fig. 288 is an anterior view of a transverse vertical section, showing the lower portion of the frontal sinuses on both sides, with a probe

FIG. 287.—Antero-posterior section showing inner wall of the orbit, and the maxillary sinus with two probes through the ostium maxillare. The conical elevation in the floor of the sinus is where a root of a tooth has been left, retarding resorption in this part of the floor, in the remainder of which the process has been active.

passed from the right sinus downward and slightly outward along the hiatus semilunaris, and then through the ostium maxillare into the maxillary sinus. It will be noticed that there is quite a difference in the anatomical characteristics of the anterior ethmoidal cells.

Fig. 289 is a posterior view of the same section as Fig. 288. The course of the probe can be traced as it passes downward along the hiatus semilunaris, through the ostium maxillare, and into the sinus without obstruction. There is a lack of bilateral symmetry in the unciform process and bulla ethmoidalis. As this is a section of a negro skull, the great thickness of the floor of the maxillary sinus is accounted for.

Fig. 290 gives another view of the hiatus semilunaris leading downward and backward from the frontal sinus into the middle meatus, a

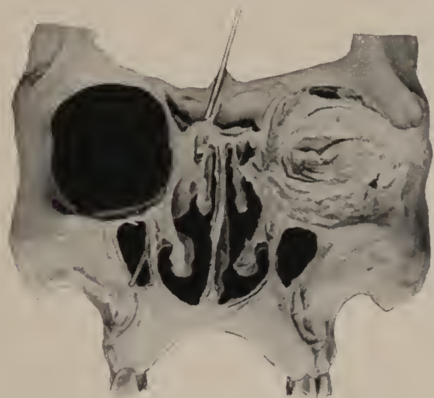


Fig. 288.—Anterior view of a vertical transverse section of a negro skull between the second premolar and the first molar tooth, showing probe passing down into the maxillary sinus, through the frontal sinus, the hiatus semilunaris, and ostium maxillare.

Fig. 289.—Posterior view of section shown in Fig. 288.

portion of the walls (bulla ethmoidalis) covering the middle ethmoidal cells having been cut away.

Fig. 291 shows two hiatuses, or infundibula, leading directly into maxillary sinus. Through the posterior hiatus a probe has been passed, the outer wall of the anterior one having been cut away in order that a better view could be obtained.

Figs. 292 and 293 illustrate a vertical transverse section, showing more direct communication between the frontal and maxillary sinuses than Figs. 288 and 289. They give posterior and anterior views of the same section, Fig. 292 having that portion

of the face removed which extends back to the premolar teeth below, and exposes the frontal sinuses above. The septum of the nose is deflected and a "spur" reaches over to the right concha. The

FIG. 290.—Interior view of the lateral wall of the nasal cavity with part of the bone cut away to show the hiatus semilunaris and the middle ethmoidal cells.

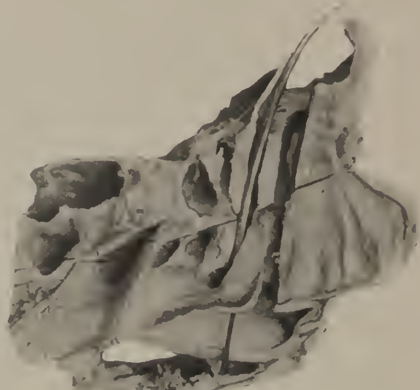


FIG. 291.—Section showing two hiatuses, both leading directly into the maxillary sinus. The posterior hiatus has a probe passing through it, the anterior one has the external wall cut away in order that a better view may be obtained.

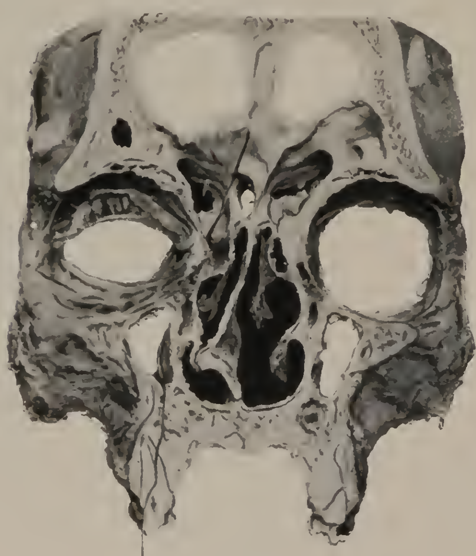


FIG. 292

FIG. 293

FIGS. 292 and 293.—Anterior and posterior views of a vertical transverse section.

frontal sinuses extend down below the middle of the orbit. Between them there is an interfrontal cell extending backward into the crista galli as is shown in Fig. 293. A wire passed downward from the right frontal sinus is again seen in the maxillary sinus. Fig. 293 shows the section cut posteriorly to the first molar teeth. The frontal sinuses extend in an outward direction over the orbits. The wire shown in Fig. 292 is seen passing downward from the right frontal sinus through the infundibulum and hiatus semilunaris and entering the maxillary sinus through the ostium maxillare.

Fig. 294.—Anterior view of vertical transverse section in the region of the first molar teeth, showing anterior ethmoidal cells, and a cell in the crista galli. The frontal sinus extends downward, becoming common with the ethmoidal cells and maxillary sinus.

Fig. 294 shows an anterior view of a vertical transverse section in the region of the premolar teeth. Between the orbits are seen the anterior ethmoidal cells, and also a sinus in the crista galli. In this case both sinuses extend upward and become common with the ethmoidal cells and frontal sinuses.

Fig. 295 gives a posterior view of a vertical transverse section cut in the region of the first molar teeth and through the crista galli. The septum is deflected toward the left side; the right maxillary sinus extends upward and inward, terminating in a large opening into the

hiatus semilunaris without a true line of demarcation. The left maxillary sinus extends forward into the infra-orbital ridge, forming an infra-orbital sinus somewhat similar to those shown in Figs. 223, 224, 229, 230, 276 and 277. The numerous pockets in the anterior portion of the maxillary sinus would render it difficult to treat should it become diseased.

Fig. 296 shows a posterior view of a vertical transverse section from the skull of an aged person. The floor of the maxillary sinus, the nasal

Fig. 295.—Posterior view of a vertical transverse section through the first molar teeth. The right hiatus semilunaris in this subject communicates with the maxillary sinus without a true ostium maxillare.

and the lower border of the alveolar process are almost on a horizontal line. The left maxillary sinus extends upward until it passes into the frontal sinus, without any line of demarcation between sinuses or cells. In the crista galli is seen a small sinus or cell which extends forward into the frontal sinus. This last formation is also shown in Figs. 269, 281, 282, 292, 293 and 294.

Fig. 297 shows a posterior view of a vertical transverse section cut behind the first molar teeth. The maxillary sinuses are almost cuboidal in shape and extend down below the floor of the nasal cavities

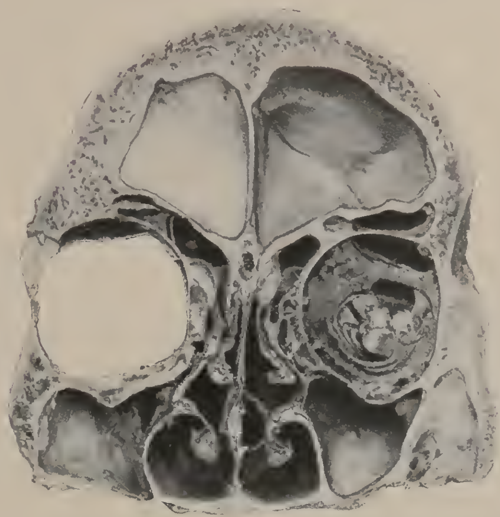


FIG. 296.—Posterior view of a vertical transverse section in the region of the ostium maxillare. From the skull of an aged person. The floor of the nasal cavity, the alveolar process, and the floor of the sinus are nearly on the same level. The left maxillary sinus extends upward through the region of the anterior ethmoidal cell into the frontal sinus without a line of demarcation between them.

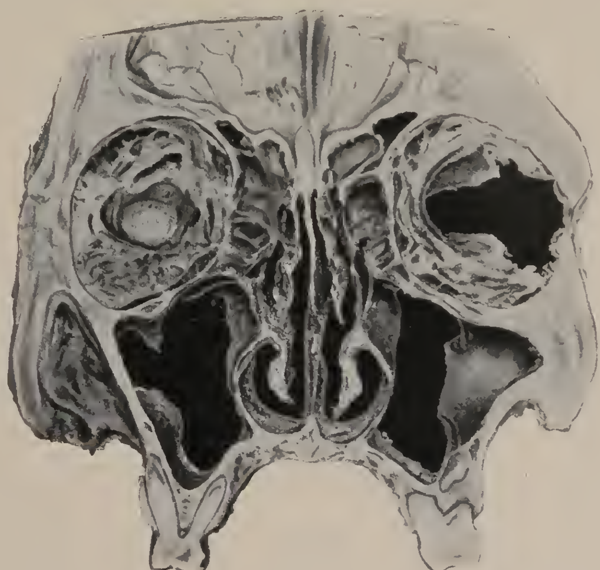


FIG. 297.—Posterior view of a vertical transverse section near the first molar teeth, showing maxillary sinuses which are nearly cuboidal in shape and which extend downward below the floor of the nasal cavity. The nasal cavity is narrow and the walls dividing it from the sinuses are concavo-convex in their vertical direction.

inward and toward the medial line, outward into the zygomatic bones, and upward into the ethmoidal cells. The inner walls are not straight, as in Figs. 196 and 197. Starting at the floor of the sinus, almost over the centre of the dome of the mouth, the inner wall, as it extends upward, curves outwardly, then inwardly to the point at which the inferior concha projects into the nasal cavity. This formation leaves a very narrow or contracted nasal cavity, a deformity also shown in Fig. 284.

FIG. 298.—Posterior view of a vertical transverse section in the region of the second premolar. showing wires passing from the frontal sinuses into the maxillary sinuses.

Fig. 298 is a posterior view of a section made back of the premolar teeth. On either side a wire has been passed from the two frontal sinuses down through the ostium frontalis into the hiatus semilunaris and thence into the maxillary sinus; the wire on the left side can be seen at various points as it passes downward. This condition indicates direct communication between the frontal and maxillary sinuses. There are also two large cells between the plates of the middle concha. In the upper median corner of the maxillary sinus, especially in the left one, is a septum forming an infra-orbital sinus.

CHAPTER XII.

THE RELATION BETWEEN THE MOUTH, TONGUE, PHARYNX, AND NASAL CHAMBER.

Frozen Sections.—The sections of the head which have hitherto been described were cut from partly dried specimens which answer the purpose very well, especially in and about the nose and its associated sinuses and cells, but they have one serious fault—the soft tissues have so shrunken that they are far from showing what they were in a fresh condition. Many of the modern applied anatomists have adopted the following plan for the study of the relative values of these parts.

The bodies secured for this work should be those that have not lost their true anatomical form through disease. They should be prepared as soon as possible after death, first by injecting a solution of formalin to harden the soft tissues, followed by injection of a magma of colored plaster of Paris, after which the body should be covered with a coating of vaselin and wrapped in cloths to prevent evaporation, and placed in a refrigerator at a temperature of about 15° F. When thoroughly frozen it is ready for sectionizing. The saw for making the sections should have a thin, broad blade, with fine, chisel-shaped teeth; in this way the finest bone can be cut without fracture, and even the soft tissue of the brain without displacement.

The following illustrations are made from frozen sections:

Fig. 299 is an illustration made from a section cut horizontally, just above the mylohyoid muscle looking upward to the base of the tongue. The various structures shown are indicated on the margin. It will be noticed that the tongue rests very close to the inner surface of the mandible and the pterygoideus internus muscle, the cross section of the pharynx is shown with the point of the uvula in view. Should the mandible be compressed and a narrow dental arch exist, the tongue

would be forced backward into the pharyngeal space, interfering with nasal respiration and other functions of the nasal cavity.

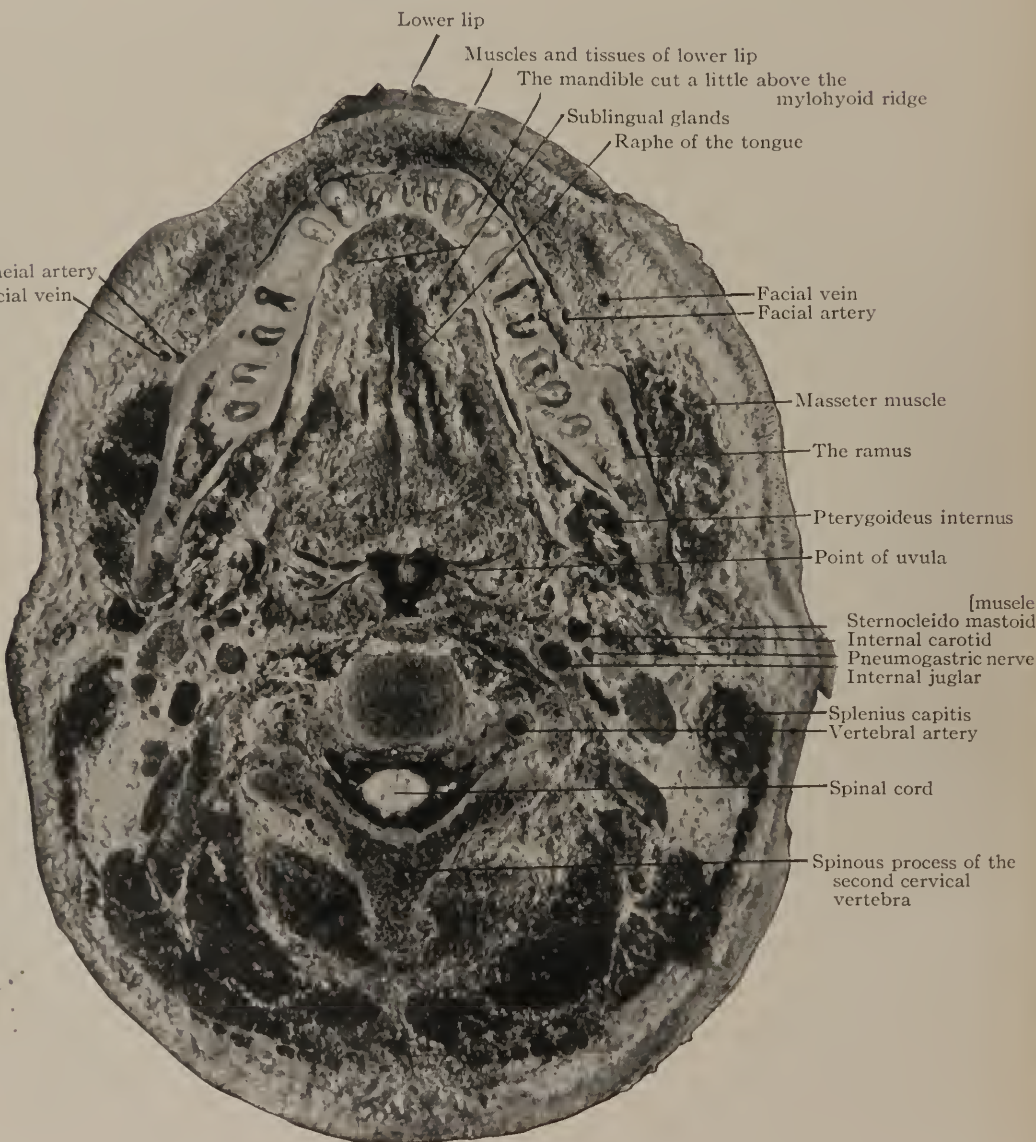


FIG. 299

Fig. 300 is made from a horizontal section at the junction of the upper lip and nose, showing a longitudinal section of the septum of

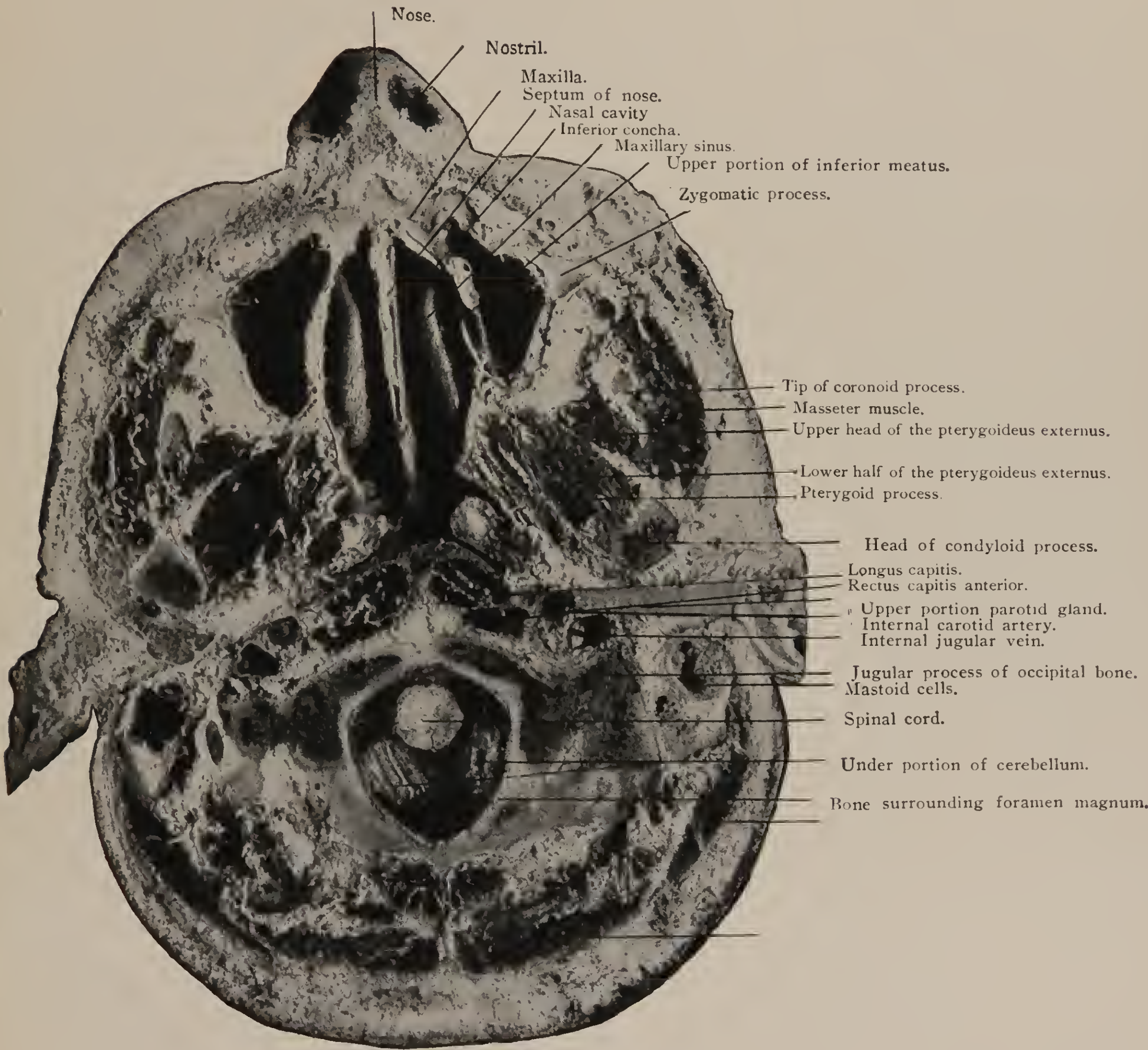


Fig. 300

the nose, the lower borders of the inferior concha, and the maxillary sinus. Within the outer wall of the nasal cavity the longitudinal

section of the auditory tube may be seen, and a little posterior, the pharyngeal recess.

Fig. 301 is from a sagittal section of a frozen skull, showing the various structures of the brain. It also gives a true idea of the lateral portion of the nasal cavity, the hard and soft palates, the pharynx, the mouth, the tongue and the epiglottis, and their relations to each other. The first incisor teeth are in good occlusion. The mouth is nearly filled by the tongue, leaving but little space under the arch of the palate. The tongue also extends well back into the oropharynx, coming in contact with the soft palate, which is carried backward against the postpharyngeal wall. The epiglottis at the base of the tongue rests slightly against the back of the pharynx, leaving but little space for respiration which, however, is sufficient when the individual is at rest. But during exertion, when more breathing space is required, the mouth is opened and the space in the pharyngeal region is increased. In this section the floor of the nasal cavity extends from the anterior nares backward and slightly downward almost to the postpharyngeal wall without a line of demarcation.

The general shape of the roof of the mouth at the median line is well displayed, and may be described as extending from the anterior teeth backward and slightly downward in a concave line nearly to the postpharyngeal wall.

In the normal living subject when the mouth is closed, the soft palate, the posterior border of the tongue, and the epiglottis are all in close proximity to the postpharyngeal wall. The soft palate, on its nasal surface is higher along the center line than at the edges, a shape which causes the fluids from the nose and its accessory sinuses and cells to be directed toward the outer wall of the pharynx and on to the esophagus. The dorsum of the tongue also acts in a similar manner for the oral cavity. The epiglottis is so shaped as to throw the fluids to the side of the pharynx past the opening of the pharynx. It does not, as described by some, shut down like a trap-door over the glottis to prevent fluids from passing into it.

Fig. 302 is from a vertical transverse section of a negro head, cut in the region of the molar teeth. The section exposes the frontal

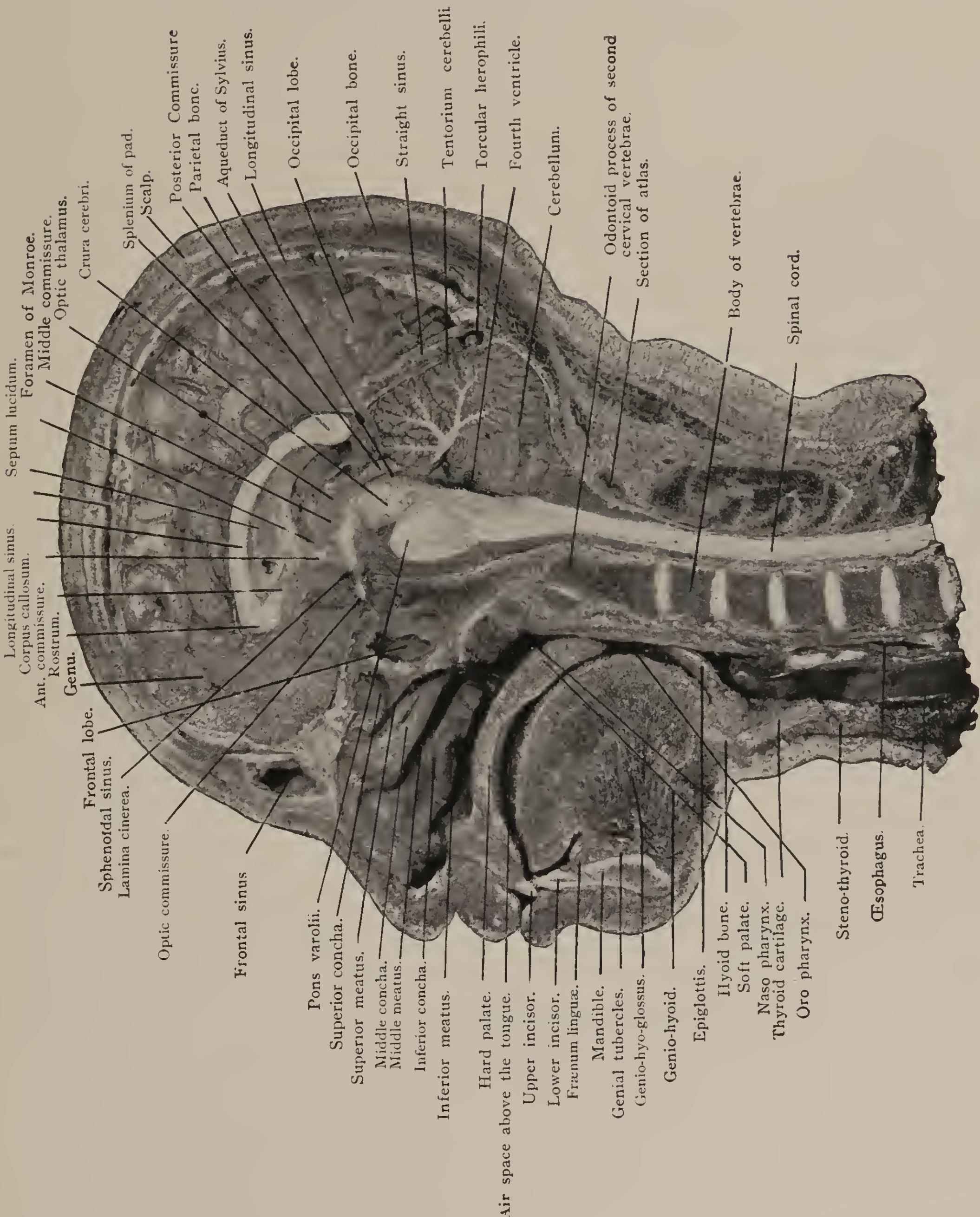


FIG. 301.—Frozen section.

sinuses, which are larger than common, and extend remarkably deep between the eyes. The septum deflects slightly to the left side of the median line. From the right side a piece of wire has been passed from

FIG. 302.—Vertical transverse section of negro head, cut in region of the molar teeth.

the sinus directly downward through the infundibulum (ostium frontalus), the hiatus semilunaris, and the ostium maxillare into the maxillary sinus. Below, and a little outward from the frontal sinuses are the transverse sections of the orbits with the tissues of the eye in position, in which may be seen cross-sections of some of the recti muscles. The dark inner membrane is the choroid. Between the orbits are the anterior ethmoidal cells, the unciform processes, the hiatus semilunaris, the middle concha, and the septum of the nose, which passes downward to the floor of the nose over the intermaxillary suture. There is a slight spur on the right side of the septum. In the lower portion of the nasal cavity are cross-sections of the inferior concha. Below the orbits are two almost typical maxillary sinuses. External to the walls of the sinuses are the muscles of mastication which pass downward to the mandible, passing through these muscular tissues are arteries, veins, and nerves.

The upper teeth, the alveolar process and the roof of the mouth are nearly typical in their formation. The space between the tongue and the roof of the mouth is similar to that shown in Fig. 301. Professor Donders[1] has spoken of this space as acting somewhat on the same principle as the vacuum chamber in an upper artificial denture. In the cross-section of the tongue will be noticed the raphe and the blood-vessels, etc., the longitudinal section of the mylohyoid muscles is also shown, with a portion of the submaxillary glands and the integuments below them. This section was cut with the mouth closed, so the lines of the fibers of the mylohyoid muscles are nearly horizontal while in Fig. 306, where the mouth was opened when frozen and sectionized, the fibers descend downward and inward.

Fig. 303 is a similar section to Fig. 302, giving an anterior view. Immediately below the dome of the skull are the meninges. It will be seen that the membranes in the centre pass downward to form the falx cerebri, the lower edge of which is attached to the posterior portion of the crista galli. At the top of the falx cerebri is a V-shaped cross-section of the longitudinal sinus. The frontal lobes of the brain

[1] Arch. of ges. Physiol., Bonn, 1875, Bd. x, S. 91.

show various convolutions, and it will be noticed that they are not symmetrical. Immediately below the brain are the inner walls of the frontal sinuses, passing well backward and outward over the orbits.

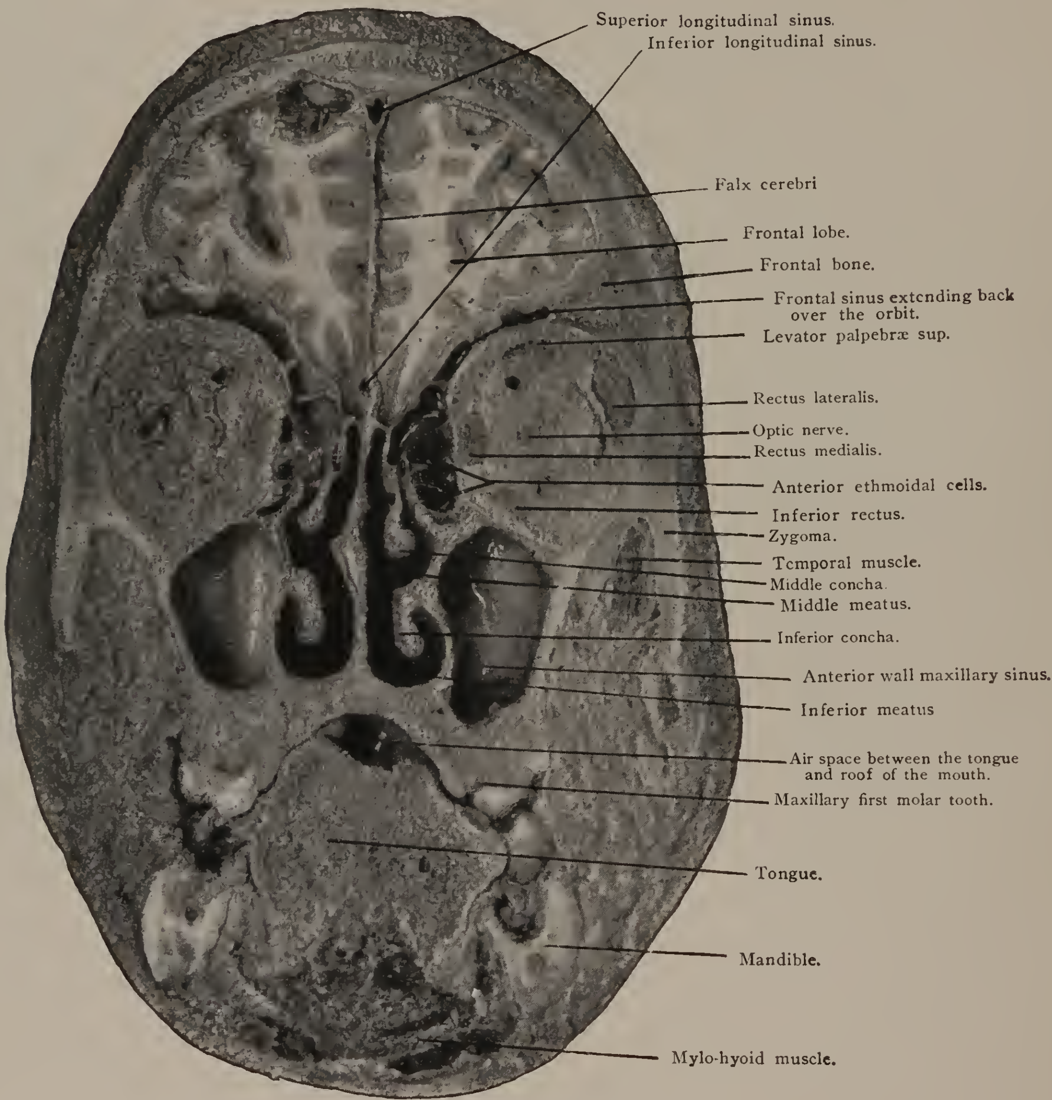


FIG. 303.—Frozen section.

Below these sinuses are the cross-sections of the orbits and eyes, the various recti muscles of the eye, the optic nerve and the ophthalmic arteries and veins. Between the orbits are the middle ethmoidal cells. Within the nasal cavity are cross-sections of the median wall and the middle and inferior concha. On each side of the lower portion of the nasal cavity are the maxillary sinuses, showing their posterior walls. The entire face is more or less compressed, especially the upper and lower jaws. The tongue has been forced out of shape by the pressure of the walls, showing that it had not sufficient power to force the alveolar process outward.

Fig. 304 is made from a transverse section of a frozen head. It exhibits a face narrowed and compressed, the maxillary sinus of the right side is lacking, and the other only rudimentary. It will be noticed that while the internal structures of the face are very much compressed, the floor of the nose is of fairly good width. The septum is crooked. The arch of the mouth is very narrow in proportion to the floor of the nose. The mandible is also narrowed, consequently the tongue is very much compressed and out of shape and is forced backward into the pharynx, thus interfering with respiration, especially when the mouth is closed. These anatomical structures are so modified and deformed that all the physiological functions are greatly interfered with.

Normally the dorsum of the tongue lies against the hard palate, but, according to Donders,[1] at the back part it is separated from the soft palate by a small space. Owing to the weight of the jaw, there is a negative pressure in this space of 2 to 4 mm. . . . The jaw is maintained in position, not by muscular effort, but by the pressure of the air; so that, if a tube from a manometer be passed between the tongue and the palate, the manometer shows a slight negative pressure corresponding to the weight of the jaw.[2]

Fig. 305 is from a vertical transverse section of the same skull used in Fig. 304, also showing a very compressed condition of the structures surrounding the oropharynx. The uvula is twisted, the tonsils, the epiglottis and the larynx are out of shape from pressure

[1] Loc. cit.

[2] Schäfer's Text-book of Physiology, 1900, ii, 314.

FIG. 304.—Vertical transverse section of a frozen head.

Fig. 305.—Vertical transverse frozen section.

of the tongue, produced, not by a narrow floor of the nose, but by a narrow dental arch. In this case it would be difficult to carry on free respiration, and impossible to perform the deep breathing required by great exertion. This morbid condition brings a further congestion and thickening of the mucous membrane of the nose and its accessory sinuses.

Fig. 306 is made from a vertical transverse section of a frozen head cut in the region of the rami of the mandible and the posterior portion of the hard palate. The subject died with the mouth open, and it was not closed before the section was made. Near the anterior portion of the pharynx it will be noticed that the fibres of the mylohyoid muscles pass backward and outward to the internal oblique lines of the mandible. If those muscles are kept in a state of tension, the angles of the mandible will be drawn toward each other and thus tend to contract the lower portion of the face. Comparison of this illustration with Fig. 302 will show great differences in regard to these muscles. In this specimen the palatoglossus and the palatopharyngeus muscles are placed on tension, narrowing the distance between the right and left tonsillar spaces. This action of the muscles naturally influences the narrowing of the face, as also does the lack of percussive force of the lower teeth against the upper. When the mouth is thrown open, the tongue leaves the roof of the mouth, thus giving passage for air; the hyoid bone and all attached to it is drawn downward. This also puts the tongue, the hyoid bone, the pharynx and other structures that are closely associated with them on a tension. The muscles of mastication are also stretched.

Fig. 307 is a transverse section of a skull that is almost symmetrical, showing the nasopharyngeal space free from adenoids. The soft palate, the uvula and the posterior portion of the tongue are in good position, the tongue and soft palate being close together. Below the tongue and a little to one side, a cross-section of the hyoid bone will be observed and below this the hyoid and cricoid cartilages, showing the inlet of the larynx and trachea. If the posterior portion of the tongue be removed, the tonsillar space will be brought in view as shown in Fig. 260. The section is also made through the brain case, the

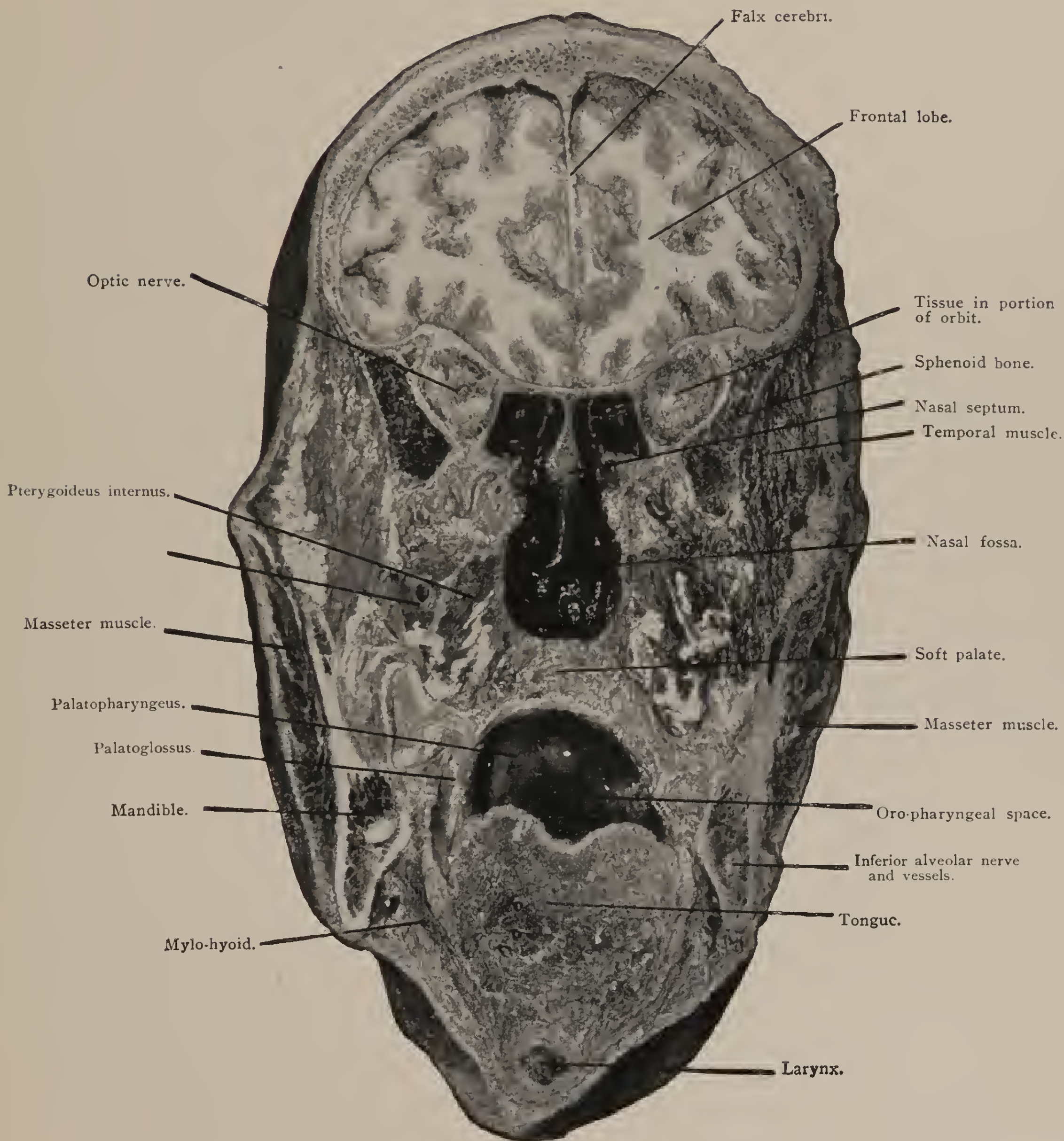

Falx cerebri.
Frontal lobe.
Optic nerve.
Tissue in portion of orbit.
Sphenoid bone.
Nasal septum.
Temporal muscle.
Pterygoideus internus.
Nasal fossa.
Masseter muscle.
Soft palate.
Palatopharyngeus.
Masseter muscle.
Palatoglossus.
Mandible.
Oro-pharyngeal space.
Inferior alveolar nerve and vessels.
Tongue.
Mylo-hyoid.
Larynx.

FIG. 306

FIG. 307.—Transverse frozen section of symmetrical skull.

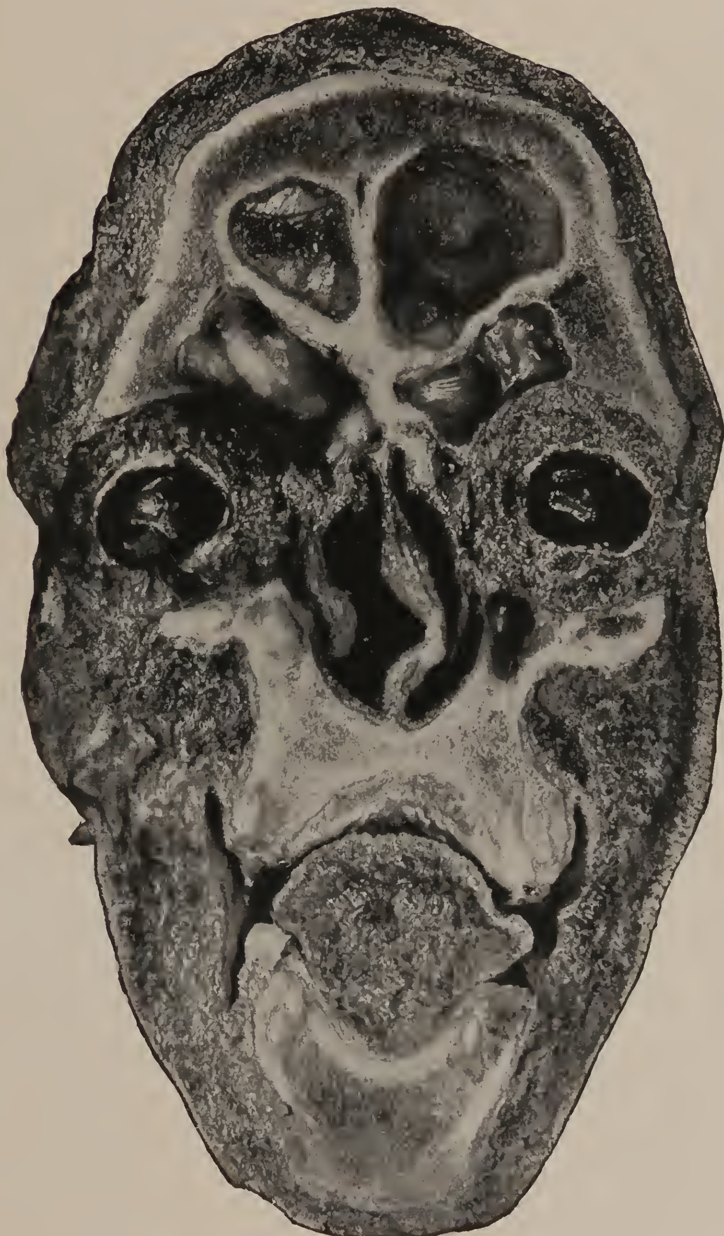


Fig. 308.—Vertical transverse section of narrow skull.

temporal muscles, the external and internal pterygoid muscles and processes, the internal maxillary arteries, the rami of the mandible, and the submaxillary gland.

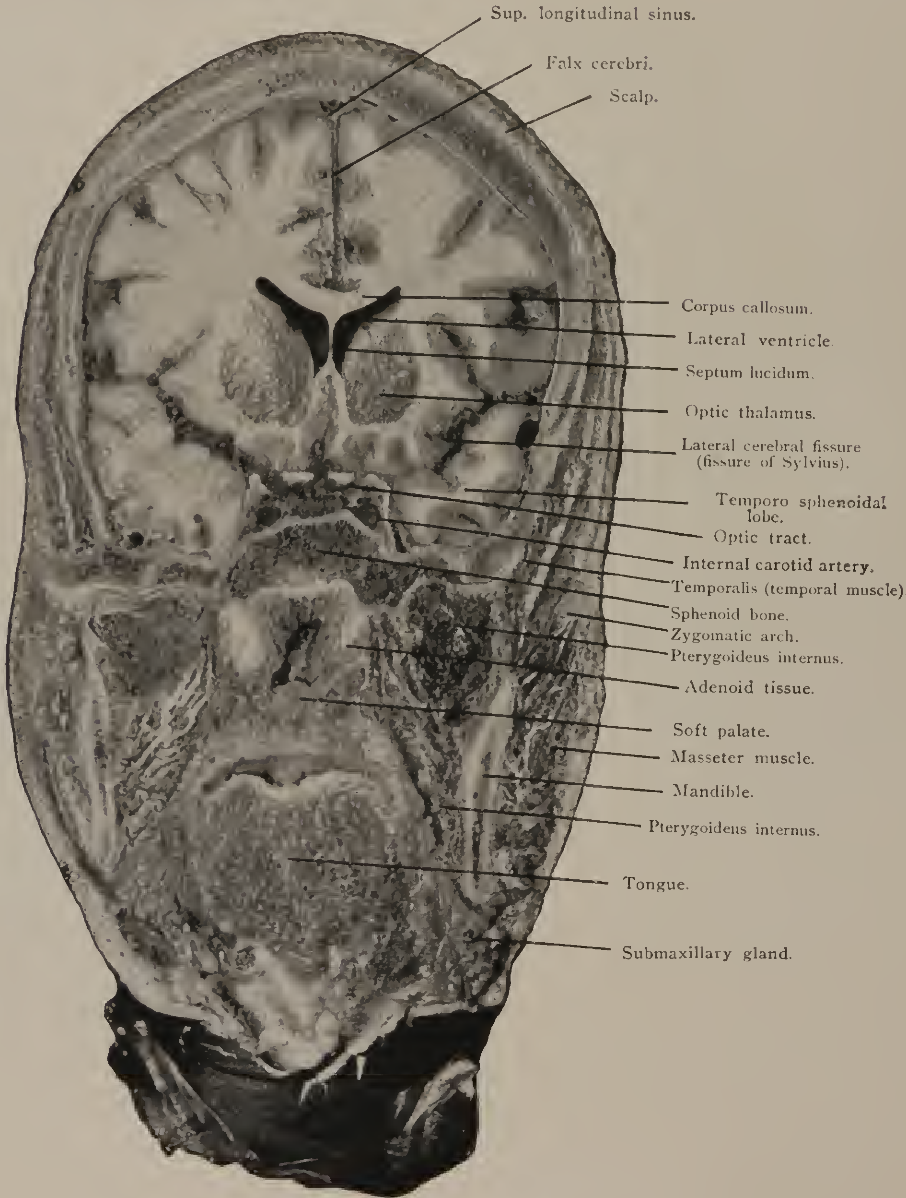


FIG. 309.—Anterior view of Fig. 308.

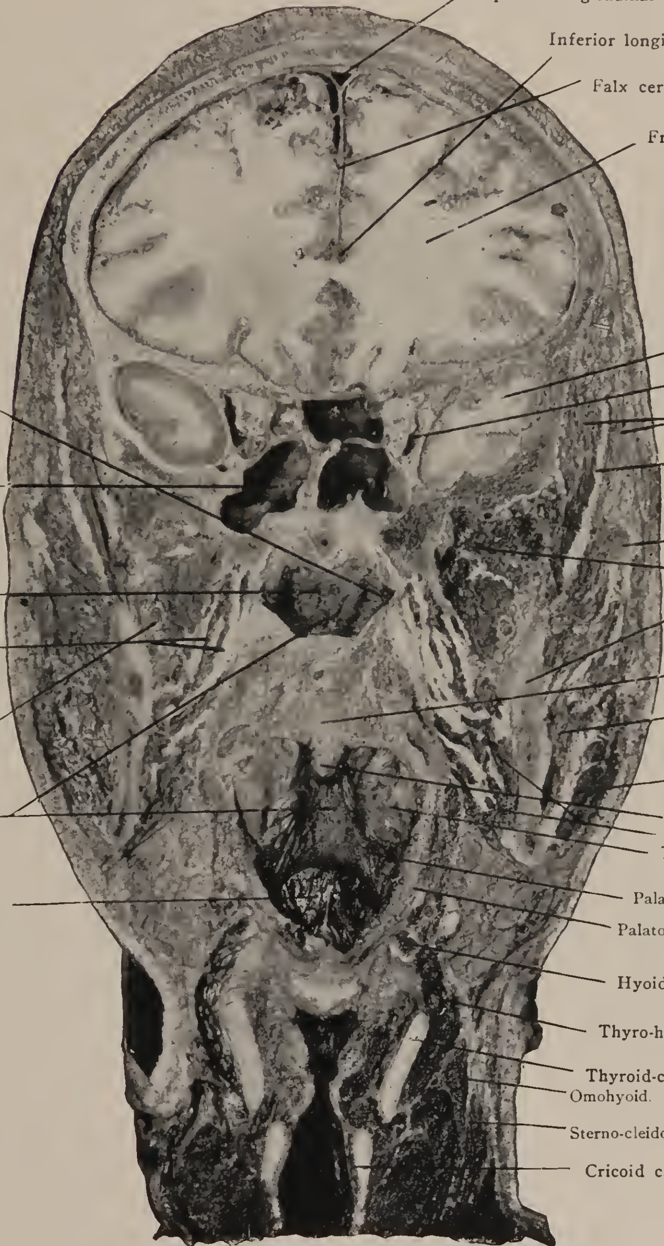


FIG. 310.—Frozen transverse vertical section.

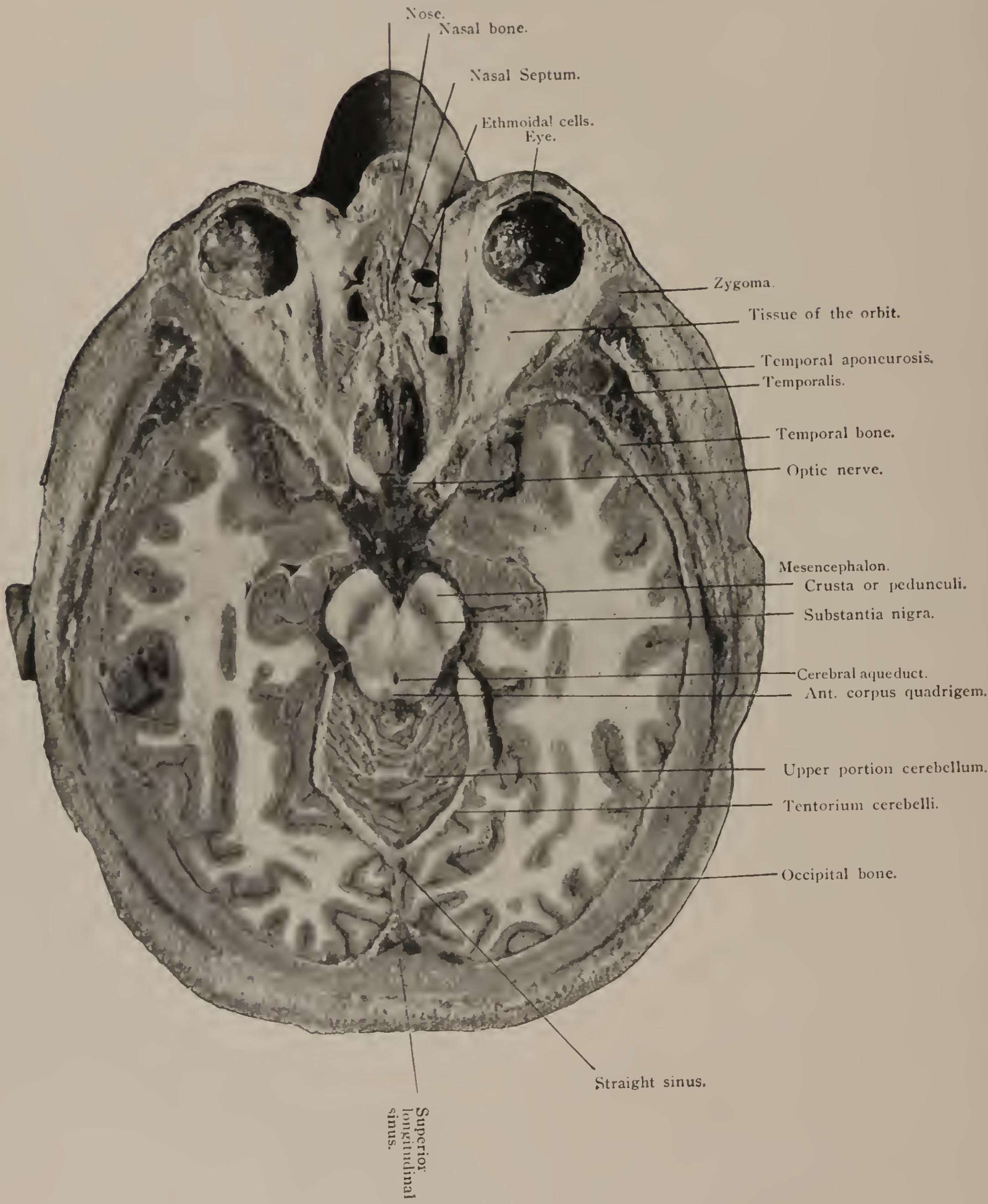


FIG. 311.—Horizontal frozen section.

Fig. 308 is a vertical transverse section of a narrow skull, showing a compressed nasal cavity, a deflected septum, lack of development of the ethmoidal cells, small maxillary sinuses and narrow alveolar arches. The tongue is compressed, part of it passing out between the jaws until it meets the cheek. When such conditions are found it usually indicates that the posterior nares are more or less obstructed, either with an osseous deposit or enlarged adenoid tissue.

Fig. 309, made from the same skull as Fig. 308, is an anterior view of a vertical transverse section cut just behind the posterior nares. Beneath the dome of the skull, the lateral ventricles may be seen under the parietal lobes of the brain, which are separated by the falx cerebri, extending downward to the corpus collosum. The temporosphenoidal lobes are also seen with the body of the sphenoid bone between them. The most important feature of this section in regard to respiration is that the nasopharyngeal space has become almost closed by the enlargement of the adenoid tissue.

Fig. 310 is a similar section to Fig. 309. In the centre of the oropharyngeal space, the uvula may be seen, below which is the postpharyngeal wall, at the bottom of this space, the convex surface of the epiglottis is depicted and in the upper and outer corners the tonsils. To the inner side of the tonsils, portions of the palatopharyngeal muscles are shown, while to the outer side, and slightly covering the tonsils anteriorally are the palatoglossus muscles.

Fig. 311 is from a horizontal section cut through the centre of the orbits, the optical foramen and the optic nerves, then backward through various tissues including the brain. This section also exposes part of the ethmoidal cells connected with the upper part of the nose. Various convolutions of the brain and cross-section of the mesencephalon are shown, also section of the cerebellum, the edges of the tentorium cerebelli, the straight sinus, the falx cerebri, and the longitudinal sinus.

CHAPTER XIII.

MODIFICATION OF THE NORMAL SHAPE OF THE BONE THROUGH ABNORMAL FORCES.

THE illustrations and descriptions already given demonstrate that there are very marked variations in the character of the bones of the face, and of the sinuses and air spaces situated in and between them. It is evident that there must be some general principles underlying these changes.

Causes of Variations in Shape.—At the beginning of the growth of the embryo, and continuing throughout life, there are two forces constantly acting upon the body which may be described as the intrinsic and extrinsic; the former giving size and bulk to the tissues, but controlled and modified by the latter, which, acting from without, tends to limit the growth and give form to the tissues. If these two forces be normal—that is, properly balanced—in potential strength and application throughout life, the result will be a normally developed organism; but if these forces be interfered with in any way, by lack of nourishment or undue external pressure, the individual may fail to develop a normal physique.

Deposit of Salts of Calcium.—If for some reason there is an insufficient quantity of salts of calcium assimilated into the bony tissue, the bones will be soft and fail to give proper shape to the body. The brain-case in such instances is apt to enlarge when the intrinsic growth of the brain forces out the soft yielding structures, while on the other hand an overamount of salts of calcium will harden the bone, and cause it to resist the intrinsic force and prevent proper development.

In early life the undue deposit of salts of calcium will solidify the sutures of the brain-case and prevent the expansion of the brain. Microcephalic skulls are sometimes caused in this way. By the use of the surgical engine, artificial fissures have been made in the skull,

which allowed the brain-case to expand, and thus enabled the brain itself to enlarge.

The slopes and forms of the heads of the various races are influenced not only by the growth of the brain but also by artificial means such as are practised by the Flathead Indians of North America (see Figs. 312 and 313) and by the prehistoric Indians of the Mesa Verde[1] (see Figs. 314–319).

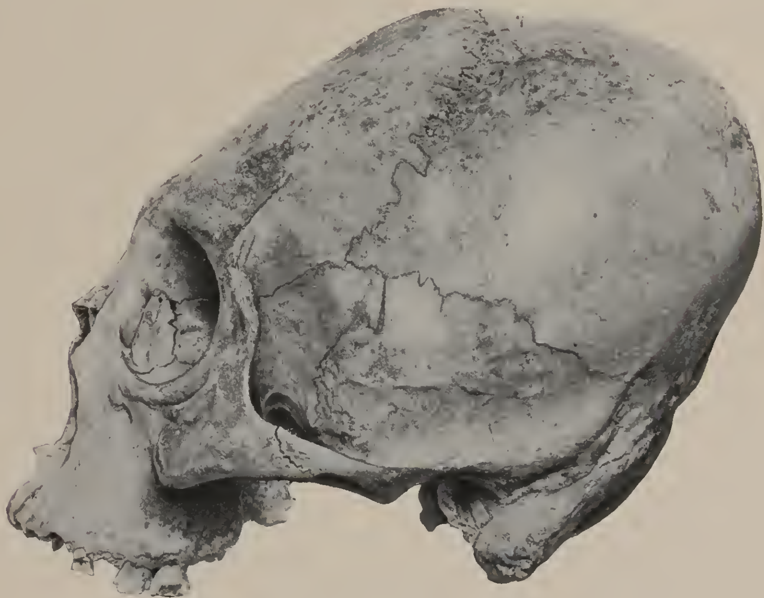


FIG. 312.—Side view of a skull of Flathead North American Indian.

Prof. Retzius gives a very interesting short description of ten prehistoric skulls, found by M. Gustaf Nordenskiöld in the cliff dwellings of the Mesa Verde, in which he observes that an artificial deformation of the crania "has been caused in early infancy by the application of pressure to the superior parieto-occipital region, this part having been depressed with some flat object.[2]

[1] A good collection of these skulls may be found in the Wister Institute, University of Pennsylvania.

[2] The Cliff Dwellers of the Mesa Verde, Southwestern Colorado, Stockholm, 1893.

FIG. 313.—Front view of same skull shown in Fig. 312.

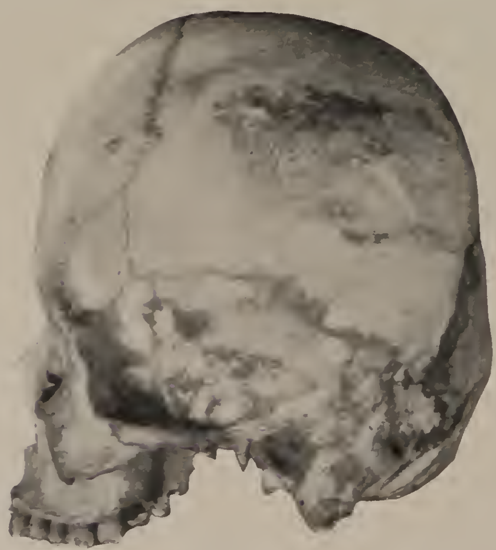


FIG. 314.—Side view of a prehistoric Indian of the Mesa Verde.

Fig. 315.—Posterior view of same skull as shown in Fig. 314.

Fig. 316.—Anterior view of the same skull as shown in Fig. 314.

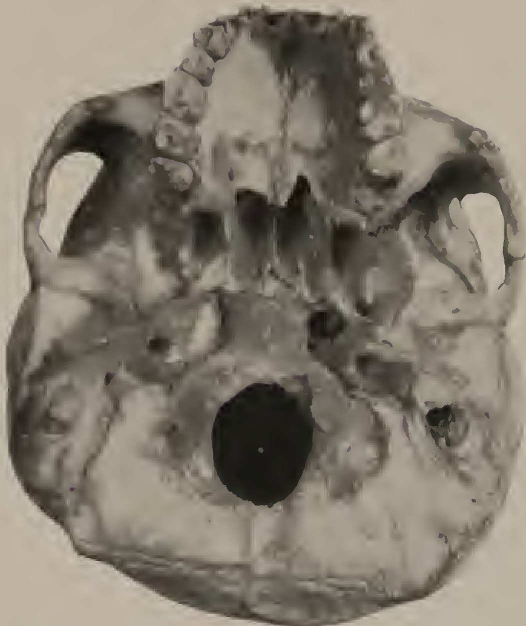


Fig. 317.—View of base of skull shown in Fig. 314.

Fig. 318.—Side view of prehistoric skull from a collection in Colorado Springs.

In August, 1915, while visiting in Denver, the writer through the courtesy of Dr. A. H. Ketcham obtained permission to examine sixty skulls, some of which had recently been excavated from the ancient cliff dwellings of the Mesa Verde, and was fortunate in being able to secure photographs and measurements of several of these artificially flattened brachycephalic skulls.

Figs. 314–319, except Fig. 318, are photographs of prehistoric skulls belonging to this collection in the Colorado State Museum.

Fig. 314 is a side view, showing result of pressure placed on the occipitoparietal region causing abnormally high dome, as evidenced by the height and corresponding diminution in the anteroposterior diameter.

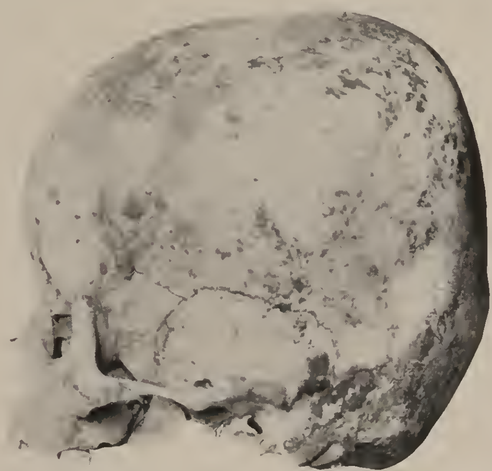


FIG. 319.—Side view of a child's skull found in the collection of the Colorado State Museum.

Fig. 315 is a posterior view of same skull, showing greatest compression in the region of the junction of the sagittal suture with the occipital bone which has caused an increase in its transverse parietal region.

Fig. 316 is an anterior view of same skull, showing decided brachycephalic type.

Fig. 317 is a view of base of skull (314), showing the abnormally short distance from the foramen magnum (basion) to the posterior portion of the skull, 61 mm., measurements of the base of this skull (see table, page 88).

FIG. 320

FIG. 321

FIGS. 320 and 321.—Side view of two skulls; Fig. 320 is of the Caucasian race, Fig. 321 is of the Fan tribe of West Africa.[1] They show great differences in conformation.

[1] The Fan tribe skull belongs to Professor E. T. Darby's collection.

Fig. 318 is a side view of prehistoric skull from collection in Colorado Springs, showing the same marked depression of the lambda and postero-occipital regions produced by artificial means, many of the teeth are lost, some during life; remaining ones are strong but rather worn.

Fig. 319 is a side view of a child's skull about four or five years of age, showing the same compression in the occipital region. By comparison with the foregoing it will be observed that this last cranium, while presenting similar features, differs in the marked prominence of the frontal region, especially on referring to the skull of the flat-headed Indian as shown in Figs. 312 and 313.

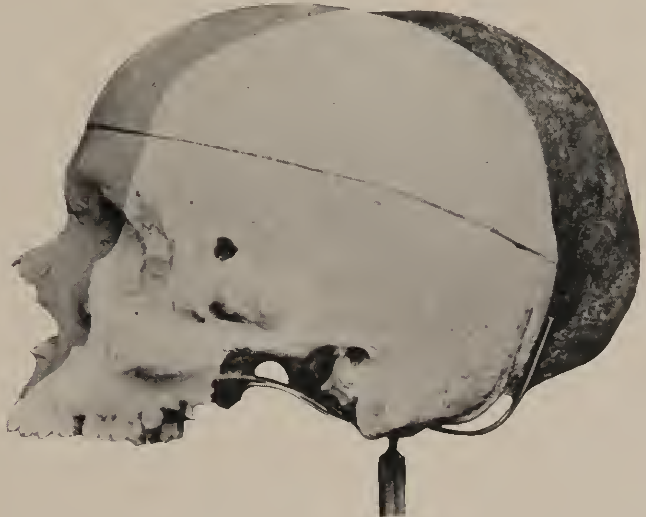


Fig. 322.—Composite picture of the two skulls shown in Figs. 320 and 321.

Where no artificial deformation exists, the brain by its intrinsic forces acting upon the bone tissue will cause the skull to expand, according to the character of the individual race. If the anterior lobes of the brain are of large size, the forehead will be carried upward and forward; if, on the contrary, the cerebellum be large, the occipital region will extend backward, while the forehead may be low and receding. The two types are well illustrated in Figs. 320 and 321. Fig. 320 is taken from a European skull, and Fig. 321 from the skull of a Fan tribe negro, West Africa. Fig. 322 is a composite picture of these two skulls,

showing their relative shapes. Figs. 323 and 324 give the bases of these two skulls.

Prehensile Type of Dentition.—A little study of these specimens brings out some features of special interest to the ethnologist. In the savage type a great predominance of development in the region of the cerebellum is found, conjoined with what may be called a prehensile type of dentition. It is believed this type was developed through continuous use of the teeth in tearing off portions of the substances which constitute the food of the savage races. The prehensile type of dentition is not found in the civilized races, and as seen in the typical skulls the cerebellum is much less than in the savage. It would appear reasonable that the retention of the large cerebellum—the original type—in the latter results from the low standard of intelligence evidenced by the persistence of the food habit which caused the prehensile type of dentition. The two pictures in Figs. 323 and 324 show that the dental arch is actually located further forward in the skull of the savage (Fig. 323) than in that of civilized man (Fig. 324). The anterior portion of the zygomatic process of the maxilla in the savage is on a line with the second molar; in the civilized man it is on a line with the second premolar; a difference equaling the space of the first molar. These observations are confirmed by a comparison of Fig. 321 from the skull of an African negro, and Fig. 320 from the skull of a Caucasian. It would seem probable that the lessened prognathism of the Caucasian race is one of the principal causes of the suggested suppression of the third molar. An example of the occasional development of a rudimentary fourth molar (the paramolar of Bolk) of a prognathous savage is seen in Fig. 325.

Rudimentary or Suppressed Molars.—There are skulls of the Caucasian races which have only rudimentary third molars; in some skulls the third molar is entirely lacking. This has been received by many writers as evidence that the third molar teeth are being lost entirely, and as an indication that men will eventually become more or less edentulous. The author is of the opinion that the jaws and the teeth of men are as good and fully formed at the present time as they were three thousand or more years ago; this does not include, however, such

jaws and teeth as are found in the Heidelberg or Sussex skulls which are prehistoric and supposed to be anywhere from two hundred thousand to a million years old. If ancient Egyptian skulls be carefully examined the rudimentary condition or complete suppression of the third molar will be found quite as frequently as in skulls belonging

Fig. 323

Fig. 324

Figs. 323 and 324.—Under view of skulls shown in Figs. 320 and 321.

relatively to the same class of people today. This condition is also occasionally found in the North American Indians. There is no difficulty today in finding jaws with good arches and with thirty-two perfectly developed teeth, in the living subject and occasionally with supernumerary or fourth molars, of which examples will be given.

Fig. 326 is made from the upper and lower jaws of a native Australian,[1] showing powerful jaws and teeth. There seems to have

FIG. 325.—Side view of a prognathous skull of a negro with eighteen teeth in the upper jaw. The roof of the mouth is shown in Fig. 346.

FIG. 326.—Side view of an upper and lower jaw of a native Australian.

[1] Belonging to the collection of Dr. E. C. Kirk.

been no caries in the teeth, but there is strong evidence of pyorrhea alveolaris. The arches are of good width.

Fig. 327 is made from a modern mandible (see skull Fig. 80), showing about as powerful a lower jaw as that shown in Fig. 326 and the teeth are good, without decay, and no evidence of pyorrhea alveolaris.

Figs. 328 and 329 are made from *x*-ray pictures of a boy[1] sixteen years of age, showing a right and a left impacted mandibular second molar. Apparently the anterior occluding surfaces have caused the resorption of the posterior roots of the first molars; there seems to be no development of the third molars, also no evidence that the lower second premolars have developed. The roots of the deciduous teeth show evidence of resorption, although there are no permanent teeth inciting this action.

Fig. 327.—Side view of a modern heavy mandible.

Fig. 330 gives an *x*-ray picture of the upper and lower jaws. There is no evidence of the development of the left third molars or of the second premolars, but as in the case of Figs. 328 and 329, the resorption of the roots of the deciduous teeth had taken place without the action of the permanent teeth.

Fig. 331 is an *x*-ray picture, showing teeth of the right side of the same jaws as Fig. 330, the third molar is developing while the second maxillary deciduous molar has been shed without the premolar to take its place. It will also be noticed that there is no development of the maxillary third molar.

[1] Taken from a patient of Dr. T. G. Barnes, Springfield, Mass.

FIG. 328

FIG. 329

FIGS. 328 and 329.—*X*-ray pictures, showing right and left impacted second molars.

Fig. 332 is an *x*-ray picture of a living patient about twenty years of age, showing a deciduous mandibular second molar, in position, there is no second premolar developing to take its place; it will be noticed that the roots of the deciduous tooth have been resorbed to a great extent.

FIG. 330.—*X*-ray of upper and lower jaw. There is no evidence of the development of the left third molar or of the second premolars.

Fig. 333 is an *x*-ray picture of an ancient Egyptian mandible,[1] showing the retention of a second deciduous molar and the absence of the developing second premolar similar to the missing premolars in Fig. 332.

[1] Belonging to the collection of Dr. E. C. Kirk.

Figs. 334 and 335 are *x*-ray pictures showing two impacted mandibular third molars in prehistoric mandibles. These two bones were found near Tuckerton, N. J., and are supposed to have belonged to a race of people inhabiting this region before the North American Indians.

Fig. 331.—*X*-ray picture of a modern jaws.

Figs. 336 and 337 are illustrations made from the left outer side and the right inner side of a mandible of a modern skull showing two impacted third molars; the left one is nearly horizontal, while the right one is badly "locked" under the posterior portion of the second molar.

Fig. 338 is made from an x-ray picture of the same mandible as shown in Figs. 336 and 337. In this way the position of the roots is

FIG. 332.—*X*-ray of modern jaws showing deciduous molar. (*X*-ray by Dr. Pancoast.)

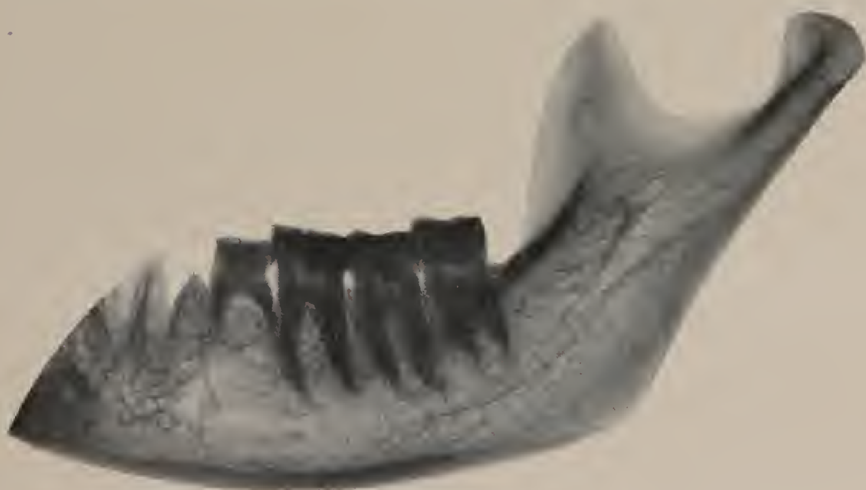


FIG. 333.—*X*-ray picture of an ancient Egyptian mandible. (*X*-ray by Dr. Pancoast.)

illustrated, shewing considerable thickening of the tissue around the roots.

Fig. 339 is an x-ray picture, showing a developing lower rudimentary fourth molar in a modern mandible.[1] There is strong evidence that a pathological condition existed in the tissue surrounding the first, second and third molar teeth, especially the second and third.

Figs. 334 and 335.—*X*-ray picture of two prehistoric mandibles, showing impacted mandibular third molars. (*X*-ray by Dr. Pancoast.)

Fig. 340 is from a photograph of a living subject, showing five maxillary incisors.

Fig. 341 is from an x-ray picture,[2] showing five erupted deciduous and five unerupted permanent incisors in the mandible of a living person.

[1] Belonging to the collection of Dr. Kirk's.

[2] *X*-ray picture loaned by Dr. Blum of New York.

FIGS. 336 and 337.—Two halves of the same mandible, showing two impacted third molars.

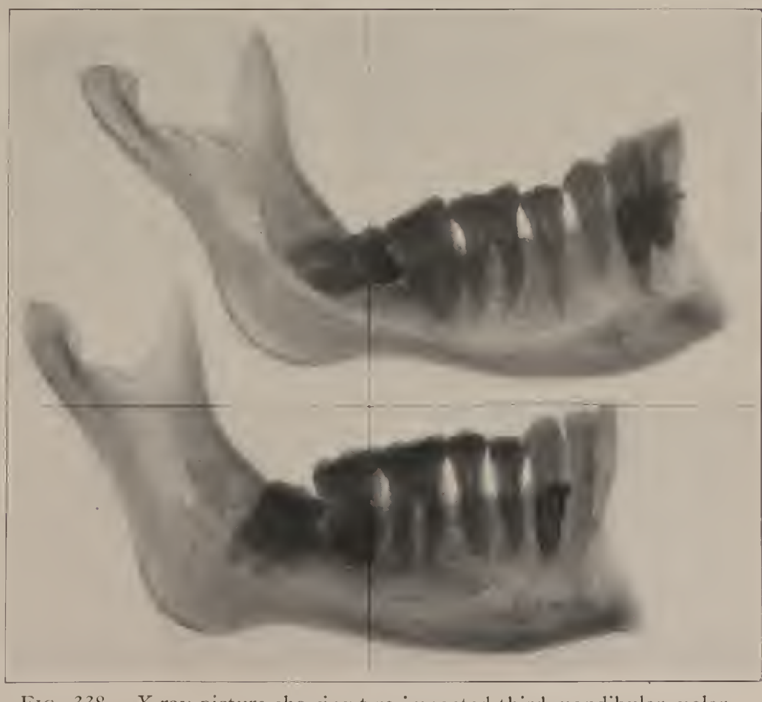


FIG. 338.—*X*-ray picture showing two impacted third mandibular molars.

FIG. 339.—*X*-ray picture showing impacted lower rudimentary fourth molar.

FIG. 340.—Photograph showing five maxillary incisors.

FIG. 341.—*X*-ray showing five deciduous and five permanent incisors.

SUPERNUMERARY PREOMLAR TEETH.

It is not unusual to find extra premolar teeth in the maxilla or mandible. Dr. Robert H. Ivy has reported a case of six mandibular premolars, one of which was impacted.[1] Dr. Inglis reports a "case of seven lower bicuspids, two supernumeraries in place and one erupting. The patient has also two supernumerary upper central incisors displacing the centrals proper, yet closely resembling them."[2]

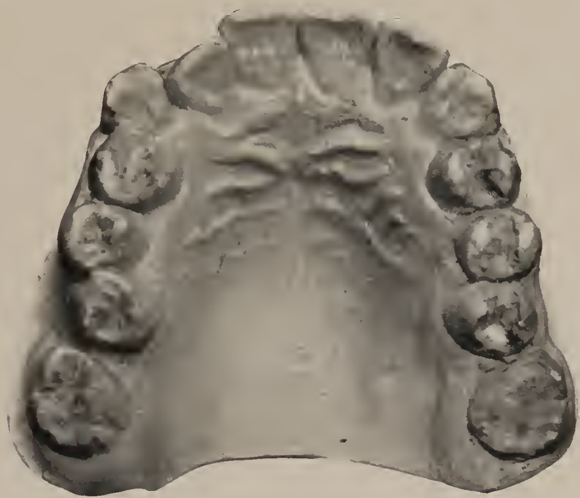


FIG. 342.—Plaster cast, showing six premolars teeth.

Dr. Hopewell-Smith mentions a case of a negro having a supernumerary premolar on each side of the mandible.[3]

Dr. A. H. Ketcham, of Denver, very kindly loaned the cast of a patient's mouth from which Fig. 342 was made, showing three premolars on each side of the maxilla.

Fig. 343, 344 and 345 were made from a clinical patient about twenty-four years of age, at the Evans Dental Institute. Examination showed that the mandibular first molars had been extracted on both sides to give room for other teeth that were in process of eruption.

[1] Dental Cosmos, June, 1915, p. 670.
[2] Dental Pathology and Therapeutics, fifth edition, p. 282.
[3] Dental Anatomy and Physiology, 1913, p. 215.

The four incisors and two canine teeth were well developed and in normal positions. Fig. 343 is an *x*-ray of the right side of the upper and lower jaws. Three premolars in fairly good position may be seen in the mandible, also a fourth impacted premolar. The lingual cusp of

FIG. 343.—*X*-ray showing four premolars. (*X*-ray by Dr. Pancoast.)

the second premolar is not well formed (see Fig. 345), the other two, however, have well-shaped crowns.

Fig. 344 is made from the left side of the face, the space between the last premolar and the second molar indicates that the first molar had

been extracted. There are three premolars in position with well-formed crowns and an impacted tooth may be seen between the first and second premolar to which no better name can be given than extra premolar, making eight premolars in the mandible.

FIG. 344.—*X*-ray showing four premolars. (*X*-ray by Dr. Pancoast.)

Fig. 345 is made from a plaster cast of the occluding surface of the mandibular teeth, showing that the incisors and canines are quite normal in position and shape, five premolars show fairly good crowns, while a sixth premolar on the right side is deformed.

It will be noticed in this illustration that there are two elevations

on the inside of the jaw, above the sublingual fossæ, indicating the position of the impacted premolars as shown in the two x-ray pictures.

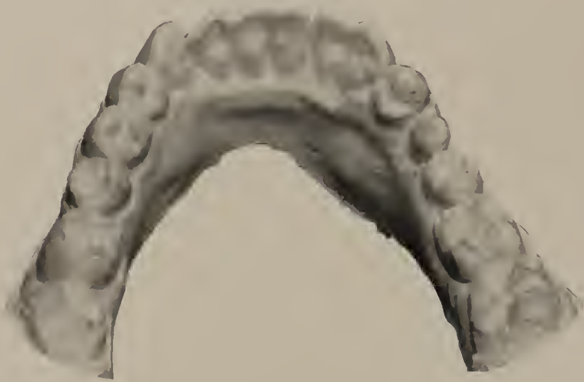


Fig. 345.—Plaster cast of lower jaw from the same as shown in X-ray, Figs. 343 and 344.

Fig. 346.—Palatal aspect of the maxillary teeth and bone, from same skull shown in Fig. 325

Fig. 346 shows the under surface of the upper jaw seen in Fig. 325 with a rudimentary fourth molar on each side of the arch.

Figs. 347 and 348 show the under surface of two upper jaws, the occluding surface of the teeth, and their relative size. Fig. 348 is about the normal size, while Fig. 347 is very much larger. In Fig. 347 there

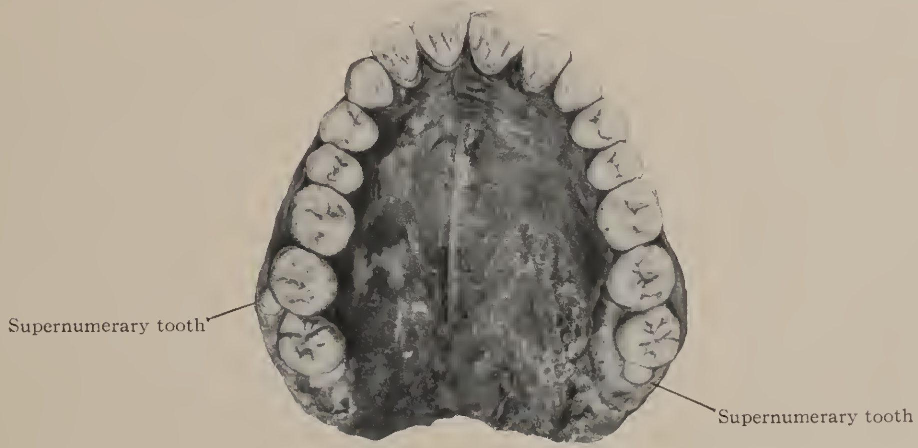


Fig. 347

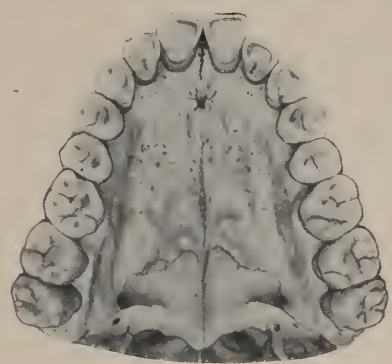


Fig. 348

Figs. 347 and 348.—View of two upper jaws. The occluding surfaces of the teeth and roofs of the mouths, and the great difference in relative size, are well shown. Fig. 347 has two rudimentary fourth molars.

are two fourth rudimentary molars, one in the line of the arch and one on the buccal side of the second molar.

Fig. 349 is a view of the palatal surface of an upper jaw, showing the occluding surfaces of the teeth, with two supernumerary teeth situated on the buccal sides of the second molars.

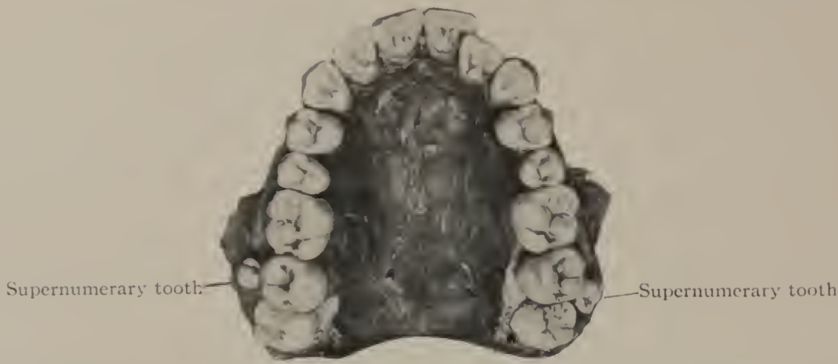


Fig. 349.—View of the roof of the mouth and occluding surfaces of the teeth from an ordinary sized upper jaw, showing two rudimentary fourth molars.

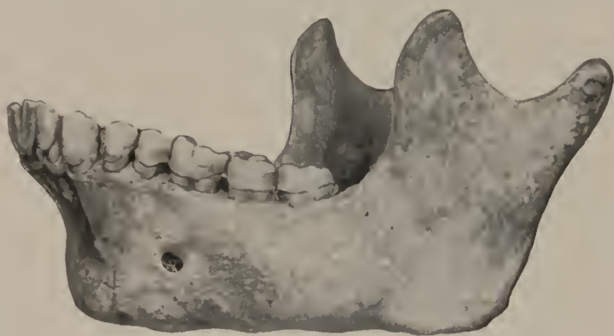


Fig. 350

Fig. 351

Figs. 350 and 351.—Two mandibles, Fig. 350 from the Fan tribe, West Africa, Fig. 351 from a Caucasian, showing the difference in the position of the teeth in relation to the ramus, the mental foramen, and the symphysis.

Comparison of Mandibles of a Caucasian and an African Negro.—Figs. 350 and 351 affords a comparison between the mandibles of the Caucasian and of the Fan tribe negro (West Africa). They were photographed upon the same plate, showing their relative size and shape. The teeth and alveolar process in Fig. 350 have been carried much further forward than those in Fig. 351. In Fig. 350 the third molar is in advance of the ramus, while in Fig. 351 the third molar, to a great extent, is posterior to the anterior margin of the ramus, the difference being about the width of a molar tooth. In Fig. 350 the mental foramen is beneath the first molar, while in Fig. 351 it is beneath the interspace between the two premolars, again a difference of about the width of a molar tooth.

CHAPTER XIV.

THE INFLUENCE OF MUSCULAR ACTION.

After the birth of the child, muscular action and various forces have direct influence over changes in the shape of the bones, according to the following rules:

The normal application of the forces affecting developing bone results in normal development of the form of the bone. Their abnormal application under the same circumstances results in the development of abnormally formed bone. Abnormal application of forces to the bone in adult life will also change and modify the shape and character of the bone tissue. The changes which may be caused by the application of abnormal forces to the developing individual are well illustrated by the disfigurements resulting from the tight bandages put upon the feet of Chinese girls of the higher class, the use of corsets to contract the waists of the European women of the analogous class, and the flattening of the skulls of certain Indians of North America by binding boards upon the heads of the children. Fig. 312 gives a side view of one of these Indians. Fig. 313 gives a front view, showing that by the compression of the frontal region downward the skull has been extended laterally.

The modification of the bones by abnormal muscular action is well illustrated by the changes found in persons suffering from true or false ankylosis of the temporomandibular articulation. The illustrations which follow are taken from a patient and from the bones of two skulls.

False Ankylosis.—Fig. 352 is from the photograph of a patient who has been suffering from false ankylosis. Judging from the general outline of the face, with its protruding lips and receding chin, one might be inclined to classify the individual as a degenerate, but the

writer believes that this picture, and others to follow, show that this is a typical face belonging to those who have or who have had ankylosis of the jaw, either true or false. This patient has suffered from a false ankylosis since about nine years of age.

Fig. 353 is taken from the right side of the same face, showing a scar extending upward and backward from the angle of the mouth to the region of the external acoustic meatus. The scar was produced by a

Fig. 352.—Characteristic appearance in the region of the lower jaw in long-standing ankylosis.

Fig. 353.—Opposite side of face of Fig. 352, showing scar caused by a gunshot wound, the effects of which produced false ankylosis.

gunshot wound. The shot in passing severed the masseter muscle as well as a portion of the buccinator. In the healing of the parts false bands of cicatricial tissue were formed, extending from the lower jaw to the zygoma and the zygomatic arch. The pterygomandibular ligament was also shortened, thus preventing the jaws from being opened. The treatment for the false ankylosis consisted in cutting the false bands and using the mouth-gag with a screw to break up the false ligaments. The operator was afterward assisted by the patient in

forcing the jaws asunder, as shown in Fig. 354. The main object in using the appliance was to stretch the temporal and masseter muscles of both sides. In a few weeks the patient could open the jaws without the appliance, as shown in Fig. 355. There was at this time sufficient improvement to permit of the mastication of food and the proper care of the teeth. The condition has since been further improved.

FIG. 354.—Application of jack-screw for forcing the mouth open in false ankylosis.

Other causes of false ankylosis are: Ossification of the pterygo-mandibular raphé, myositis ossificans affecting the masseters, pterygoid or buccinator muscles.

Typical Ankylosed Mandible.—In cases of true ankylosis of the jaw, especially those of long duration, certain changes in the form of

the mandible are noticeable, not only on the affected side when the ankylosis is unilateral, but also on the opposite side. The character of these changes is well shown in Figs. 356 and 357. Fig. 356 is a view of the unankylosed side of a typical case of true unilateral ankylosed jaw. The condyloid process is shortened and its articulating surface is changed. Instead of being rounded at the top it has more of the

Fig. 355.—Results of treatment for false ankylosis.

shape of a Gothic arch. Through this shortening of the condyloid, the coronoid process is apparently elongated. The angle of the mandible is also elongated so that it forms a projecting point, and the base of the bone under the mental foramen is considerably thickened. The mental process is much diminished in size. There is no loss of

bone, but, by the operation of causes to be referred to, a metamorphosis has been induced whereby the base of the bone has been thickened at the expense of the mental process. Owing to the same causes, the base of the bone, between the angle and a point vertically underneath

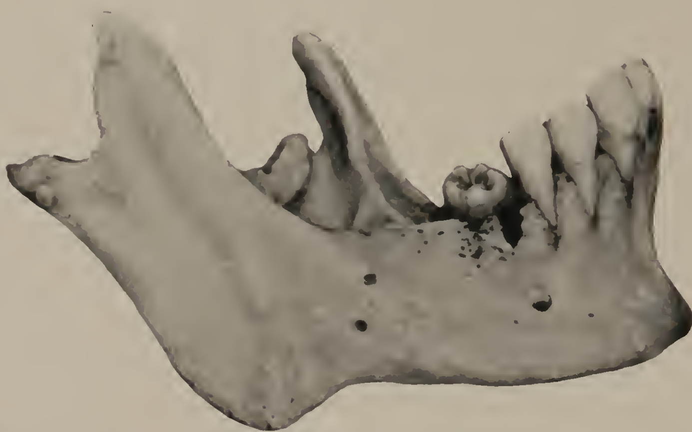


Fig. 356.—Unankylosed side of a jaw having a true unilateral ankylosed mandibular articulation.

Fig. 357.—The ankylosed side of Fig. 356.

the canine teeth, is deeply concave in outline instead of being nearly straight, as in the normal jaw.

Fig. 357 is taken from the opposite side of the face in Fig. 356, showing the condyloid process completely changed; it is broadened

out, and is sharply serrated on the articulating surface. The articulating surface of the mandibular fossa is also changed to correspond to that of the condyle with which it was interlocked. The angle of the jaw on this side is much more changed than on the opposite side, causing a deep depression in the region of the facial notch. The lower jaw, beneath the mental process, is fuller and more roughened

FIG. 358.—A skull with a true ankylosis of the mandibular articulation on the opposite side.

and the mental process more concave than on the opposite side. The concavity of the base of the jaw and the elongated angle are readily seen in the picture of the living subject (Fig. 360).

True Ankylosis.—Fig. 358 is from a skull with a complete or true unilateral ankylosis of the jaw, taken from the unankylosed side.

Fig. 359 shows the ankylosed side. The lower jaw closely resembles that shown in Fig. 357, in the descending angle, the receding chin,

etc. In all cases of prolonged ankylosis it becomes evident that there is cause for the changes observed in the form of the bones. The muscles of mastication, *i. e.*, those which elevate the lower jaw—are inactive, while those which assist in depressing the mandible become more and more active in their work, in an endeavor to overcome the fixation of the mandibular articulation. By their action the lower jaw, from the symphysis to the angle, becomes modified in proportion to the

FIG. 359.—View of the ankylosed side of Fig. 358.

contraction of the depressing muscles of the jaw. Anteriorly there are the two genioglossus, the sternothyroid, the sternohyoid, the digastricus, the omohyoideus, and the platysma, all of which are abnormally active. Their action, without the normal compensating factor of the mandibular motion, brings about in time the changes noted.

Fig. 360 is a picture of the patient shown in Figs. 352 and 353, showing an endeavor to open the mouth by the assisted action of the

muscles. It illustrates the various muscles under spasmodic action, indicating how their frequent use under such conditions may cause alterations in the form of the bone.

Changes in the Mandibular Articulation other than by Ankylosis.—Teeth becoming diseased or lost on one side of the jaw cause changes in the forms of the various bones, through the necessity of masticating on the opposite side of the mouth, and the consequent use of the jaws in an abnormal manner. In this way great alterations can be made in the mandibular articulation, and in one or both mandibular fossæ.

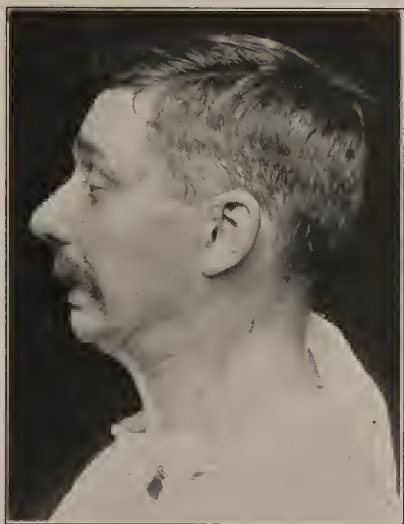


Fig. 360.—The action of the depressor muscles of the mandible in ankylosis.

The articular tubercle may be entirely lost by resorption. The places of attachment for the muscles of mastication, as the coronoid process, the outer surface of the ramus, the angle of the jaw, etc., become roughened and enlarged on the side in use, and smooth and lessened on the unused side. The spaces where the muscles have their origin, such as the external plate of the pterygoid process, the under surface of the zygomatic arch, and the temporal ridge of the skull, will also become enlarged on one side and lessened on the other.

Several illustrations are here given to show the changes brought about by the loss of teeth and changed position of occlusion.

Fig. 361 is a view of the articulation of the left side of the skull of an aged person who had lost all the teeth except three in the upper jaw and three in the lower jaw. They were not opposite to one another in normal occlusion. In order that the cutting or grinding surfaces of these teeth could come into occlusion, the left side of the jaw had to be carried forward, bringing the condyloid process of that side upon the articulating tubercle, while the right side remained in

Fig. 361.—Modification of the left mandibular articulation through the jaw being forced forward in mastication in order to bring the remaining teeth in occlusion.

a nearly normal position, as shown in Fig. 362. Upon close examination of the condyle of the left side, it is found to be flattened out, probably because of coming in contact with the articular tubercle, thus moving the point of articulation forward, or "jumping the bite." The tubercle or eminence is flattened also. The forces of mastication of the left side were but little used, and accordingly the places of origin and insertion of the muscles of that side are much less marked than the normal; while on the right side, upon which alone the function of

FIG. 362.—The right mandibular articulation from skull shown in the preceding photograph, where the condyloid process has not been carried forward.

FIG. 363.—Right side of a skull. See mandible, Fig. 9.

mastication was performed, the muscles were thus overworked, and the places of attachment and of their origin and insertion are strongly marked in consequence.

Fig. 363 gives a view of the right side of a skull. It will be seen that the three molars and one premolar of the maxilla are missing. In the mandible, all the teeth except the first and second incisors have been lost.

Fig. 364.—Left side view of the same skull as Fig. 363, showing the condyloid process, articulating on the squamous portion of the temporal bone and partly on the great wing of the sphenoid instead of the mandibular fossa.

Fig. 364 gives a view of the left side of the same skull, showing a few upper and lower teeth in occlusion. The remarkable characteristic is the abnormally small ramus, and portion of the body of the bone. The condyloid process, instead of articulating in the mandibular fossa, articulated partly on the squamous portion of the temporal bone, and partly on the great wing of the sphenoid. There seem to be two ways in which this deformity could occur. One is by the lack of growth in

the ramus and body of bone; the other theory is that the bone grew to its normal size (as there is evidence of its having articulated in the mandibular fossa), when an atrophied condition may have occurred which reduced the size of the ramus and part of the body; in order to

Fig. 365.—Under view of the articulation of the mandible as shown in Fig. 364. See base of skull, Fig. 93.

keep up occlusion of the teeth, the condyloid process moved forward, first articulating on the articular tubercle, and as the atrophy progressed, moving still forward to keep the occlusion, until the condyloid process reached the position shown in the illustration.

CHAPTER XV.

HYPERTROPHY OF THE GUMS AND ALVEOLAR PROCESS.

ABNORMAL growth of the bone may produce almost the same effect, so far as appearances go, as the modification caused by abnormal muscular action. In February, 1893, Dr. J. W. Hisey, of Cleveland, brought to the Hospital of Oral Surgery a boy of fifteen years. The

FIG. 366.—From the photograph of a lad suffering from hypertrophy of the gums and alveolar process.

FIG. 367.—Tissue removed from upper jaw of patient shown in Fig. 366.

boy was well developed, bright, intelligent, and well educated. He was afflicted with the most remarkable case of hypertrophy of the gums and alveolar process that the writer has seen recorded. The case was operated upon by the late Professor Garretson and the writer, February 17 and March 11, 1893.[1]

[1] A full description of the operation will be found in the Dental Cosmos, June, 1893.

Fig. 366 is from a photograph of the lad taken before the operation. Similarly to the first picture shown in the ankylosis series, this boy appears to have anything but an intelligent face. On February 17,

Fig. 368.—Tissue removed from the lower jaw of patient shown in Fig. 366.

Fig. 369.—From a photograph taken three weeks after the removal of the tissue in Figs. 367 and 368

Professor Garretson decided that it was best to open the upper lip at the median line and carry the incision around to the alæ of the nose. By the aid of the surgical engine and other instruments, the portion

shown in Fig. 367 was removed from the upper jaw. It was thought best not to remove the abnormal tissue from the lower jaw at this operation, so it was delayed until March 11, when the mass of tissue shown in Fig. 368 was removed from the lower jaw. This last was accomplished without cutting the lip.

Fig. 369 is from a photograph taken about April 28, seven weeks after the second operation; the parts were thoroughly healed and the general health of the patient was good. He experienced less difficulty

Fig. 370.—From a photograph six years after the operation upon the person represented in Fig. 330.

in articulating than previous to the operation, and the improvement in his speech and general appearance was very marked.

Artificial dentures were supplied in due time.

Fig. 370 is made from a photograph taken six years after the operation. To judge from this, the young man certainly does not look like a degenerate. The operation has evidently made a tremendous improvement in his appearance, and it seems to be conclusively demonstrated that Professor Garretson was right in his judgment.

CHAPTER XVI.

THE RELATION OF THE TWO JAWS.

The Relation of the Upper and Lower Jaws Varies Throughout Life.—There is also a difference in their relative time of development. The lower jaw is developed slightly in advance of the upper one and is formed from two processes or buds, the upper jaw being formed from four processes or buds—two from the sides and two from above. Occasionally these four processes fail to completely unite. This lack of union varies from a slight *cleft palate* or *hare-lip* to a double cleft palate and double hare-lip. In a few very exceptional cases there has been an entire lack of union of these parts, leaving the mouth, nasal cavity, and orbits as one common cavity. Various theories have been advanced for this lack of union, the most prominent, perhaps, being that of malnutrition of the parts during the time when the union should take place. While agreeing that malnutrition is probably largely responsible, the writer offers as a plausible explanation of the manner of its operation the idea that as the lower jaw is formed in advance of the upper one, when undue pressure is exerted upon it, it is forced in between the four processes forming the upper jaw, thus mechanically preventing them from coming together.

The normal position of the fetus *in utero* is such that the weight of the entire fetal body could be thrown upon the vertex, the pressure thus exerted would tend to force the mandible into contact with the sternal region and compress the forming jaws together. The relatively advanced development of the mandible, as compared with that of the forming maxilla, would under the circumstances referred to, and especially in cases of low nutritional standard, interfere with the normal closure of the brachial arches and tend to produce a permanent coloboma.

If an examination be made of a young child with a complete cleft, it will be noticed that the upper alveolar ridge is immediately over

the alveolar ridge of the lower jaw, or it may be external to it; in the normal child or in the person of advanced age the upper alveolar ridge is in vertical line within that of the lower jaw, as is well illustrated in Figs. 196 and 372 and in Figs. 375 and 376.

Congenital cleft palate has also been attributed to the effects of syphilis during intra-uterine life. (Hopewell-Smith.)

Manner of Drinking.—Individuals having cleft palate, especially those with double cleft, have not the power to drink when the anterior portion of the mouth is on a lower level than the posterior portion. They are compelled to raise the head, thus throwing the fluid back into the pharynx, similar to the manner in which a chicken drinks. This mode of drinking is normal with the chicken, as it has naturally a cleft palate, and has not the power of suction as performed in man by the glossopalatinus muscle. A child with a complete cleft has no power of suction with the lips, but if an artificial nipple be long and large, the child may seize it with the palatal muscles, which will give the power of sucking or of drawing the fluid through the nipple.[1]

Mold upon which the Maxilla is Formed.—It is generally accepted that the lower jaw acts as a matrix or mold upon which the upper jaw is formed. To an extent it certainly becomes the mold upon which the inferior border of the upper jaw is formed, as the latter comes in contact with its inner edges. This action also influences the general contour and shape of the superior alveolar ridge and roof of the mouth.

Fig. 371 is a picture taken from the skull of a fully developed fetus. The skull has been cut vertically and transversely in the region of the developing deciduous teeth of both jaws, showing the jaws in transverse section. The skull is quite symmetrical. It is plainly to be seen that the width of the upper jaw is much less than that of the lower.[2] As a further evidence of this fact, if vertical lines are drawn through the centres of the tooth-germs and the alveolar process of each jaw, it will be found that the lines of the upper jaw are on the inner side of those of the lower jaw, the extent of the difference being about one-half of the thickness of the lower jaw.

[1] For surgical procedure and further description of cleft palate, see Brophy's Oral Surgery, p. 563.

[2] For description of other features shown in this illustration, see Fig. 195.

Fig. 372 is taken from an adult jaw. If lines be drawn through the longitudinal axes of the upper and the lower teeth, it will be found that those through the former, as they extend toward the coronal surfaces, pass a little outward, while those passing up through the lower teeth incline inward. This is evidence that the relation found in the fetus has been continued, and that all through the period of growth of the lower jaw and development of its alveolar process, the latter has been directed inward, while the upper alveolar process has extended out-

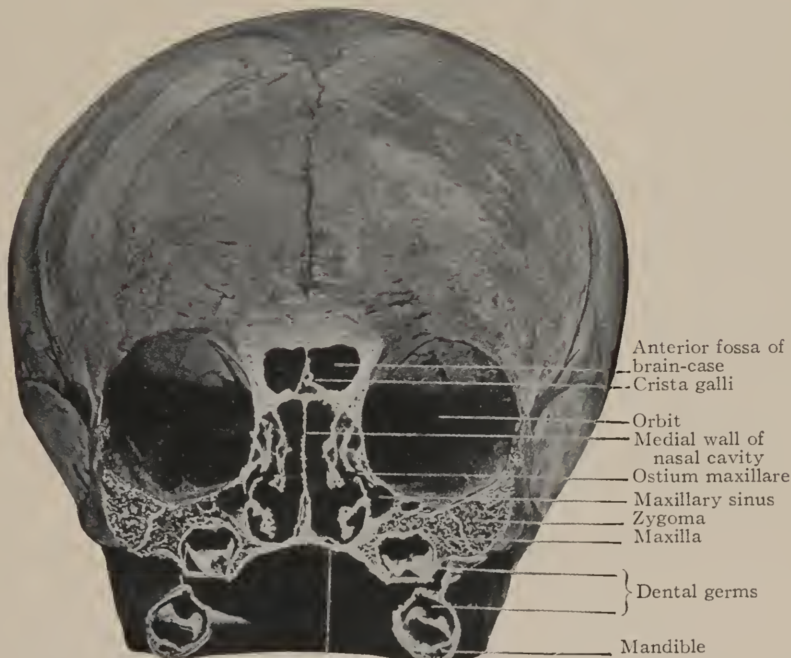


Fig. 371.—Vertical transverse section through the orbits, the nasal cavity, and the premolar teeth.

wardly, so that the cusps of the upper permanent teeth, when fully developed normally, bite over the outer cusps of the lower teeth occluding with them. If the teeth and alveolar process be excluded, it will be observed, as in the fetal skull, that the upper jaw is much smaller than the lower.

Fig. 373 is from the anterior section of Fig. 372. It illustrates the occlusion of the anterior teeth, also shows the cortical and the cancellated tissue of the mandible.

The Resorption of the Alveolar Process.—As the alveolar process belongs to the teeth and is developed with them, and its function is that of holding them in position, it disappears to a greater or less extent after the teeth are lost. Hopewell-Smith has shown that this resorption

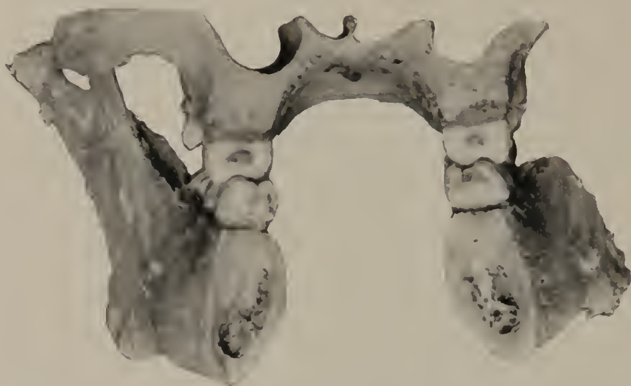


FIG. 372.—Anterior view of a vertical transverse section through the lower jaw and the lower portion of the upper jaw.

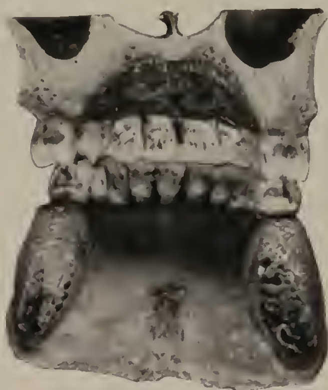


FIG. 373.—Anterior section of Fig. 372.

of bone may begin at a very early age—on account of the fact that, histologically, the structure of the osseous tissue differs considerably from that found elsewhere, and its blood supply is very inadequate.

The manner of its resorption differs in the two jaws. In the upper the external plate disappears more rapidly than the internal, which

persists for a considerably longer period, though in extreme old age the entire process is lost, leaving a very narrow jaw and a small roof to the mouth (see Figs. 375 and 377).

In the lower jaw the resorption of the two plates takes place more evenly. Usually they are resorbed in such a manner that a slight ridge is left between the places which they formerly occupied.

The Relations in Extreme Old Age.—As a result, there is produced a twofold effect upon the relation of the jaws. As the resorption of the alveolar process goes on, the vertical distance between the body of the lower jaw and that of the upper is lessened, while the natural difference in their width is increased. The area of the upper jaw becomes smaller in proportion to that of the lower, the axes of the mandible extending further outward. In the endeavor to close the jaws under these circumstances, the lower is projected further forward as it rises to meet the upper, until, in extreme cases, it may pass absolutely outside of the upper. This is a frequent characteristic of the edentulous jaw in old age.

If properly fitting artificial dentures are placed in the mouth promptly after the loss of the natural teeth, the resorption of the alveolar process, and particularly the change in the angle of the jaw, will be retarded. Thus, if these teeth are replaced from time to time by dentures adjusted to the conditions as the processes recede, this characteristic change of old age will be overcome to a very large extent.

Figs. 374 and 375 are taken from two skulls of about the same shape and size. Fig. 374 is from an adult of about twenty-five years, having a full series of normally occluded teeth. The direction of the upper and lower teeth can be observed as described. Fig. 375 is from a person of seventy-five years or more, where all the teeth were lost and the alveolar process resorbed, showing the upper and lower jaws in their normal shape and relations.

Figs. 376 and 377 are a side view of the same skulls shown in Figs. 374 and 375. It seems evident from these skulls, which are typical and not exceptional, that if the teeth be lost and the alveolar process resorbed after middle life, the upper and lower jaws cannot be again brought into occlusion through their alveolar borders.

Causes of Malformation of the Jaws.—The normal action and reaction between the two jaws has been spoken of as producing irregu-

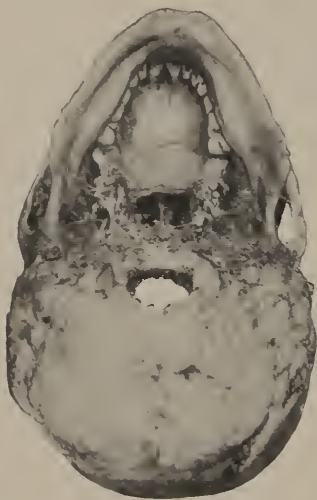


Fig. 374

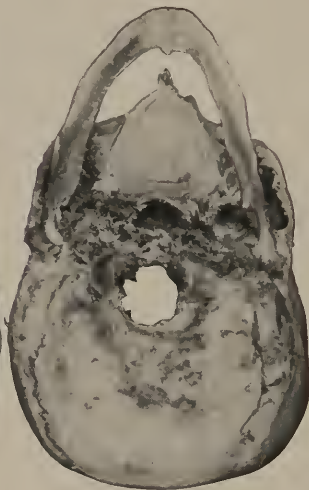


Fig. 375

Figs. 374 and 375.—Two adult skulls viewed from below: Fig. 374 from a subject about twenty years old; Fig. 375 from one well advanced in years.

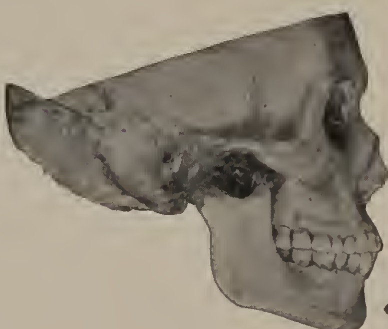


Fig. 376

Fig. 377

Figs. 376 and 377.—Side view of the two skulls shown in Figs. 374 and 375.

larities in the shape of the arches, of the roof of the mouth, and in the position of the teeth. In general, it may be said that any cause which

prevents the normal occlusion of the jaws, during either rest, speech, or mastication, will bring about malformation of these parts. Among the causes which prevent the normal bringing together of the jaws may be mentioned abnormal mouth-breathing, inflammation of the bone, of its periosteum or of the pericementum, or conditions causing pain when the teeth come in contact. Abnormal mouth-breathing should be corrected, whether it is caused by bony obstruction, in hypertrophy of the mucous membrane, or by adenoid growths in or about the naso-pharyngeal space or by narrow dental arches. While the jaws are kept apart the muscles in connection with the orbicularis oris are somewhat tightened, and a pressure which has a tendency to force the teeth inward is brought to bear upon the non-occluding teeth, causing malocclusion. While this feature has received very general acceptance, it is, in the opinion of the writer, merely an incidental factor, and of far less etiological significance than the loss of the developing and molding influence which directly results from the percussive force of occlusion exerted by the mandible upon the maxillary arch. The presence of adenoid growths in the nasopharynx, or in fact any cause which interferes with the normal closing of the mouth, at once interferes with occlusion, which, in view of more recent studies, the writer regards as the most potent factor in the normal development of the relation of the upper to the lower dentures.

It is, of course, to be understood that the factor behind these anatomical variations, leading to asymmetrical development, is necessarily that of nutrition. Some interference with local nutrition has brought about functional disturbance of a part, and this, in turn, a corresponding modification of anatomical form.

The writer in conclusion suggests that the data which are embodied in this work will not be regarded as exhaustive of the subject, but rather as an indication of the magnitude of the field to be studied, and more particularly as suggestive of the rational method by which the subject should be investigated.

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